

RESEARCH

SEPTEMBER 25, 2019

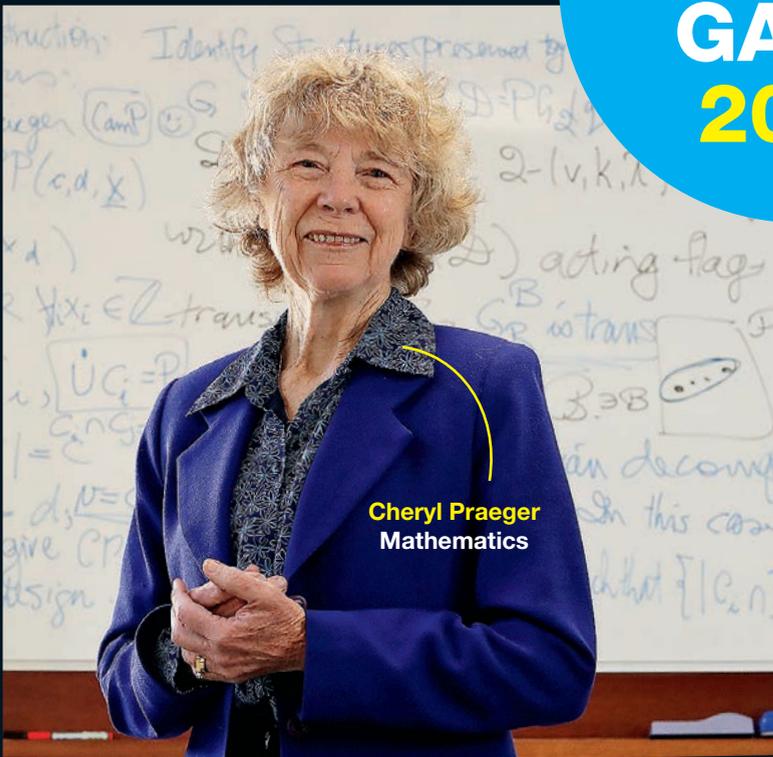


John Handmer
Emergency management



Cheryl Dissanayake
Autism

**ON TOP
OF THEIR
GAME
2019**

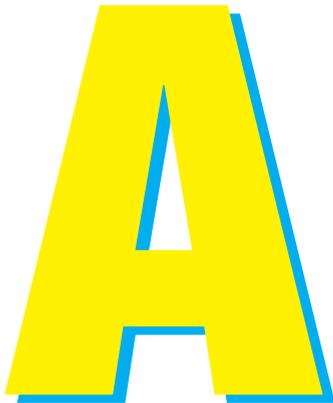
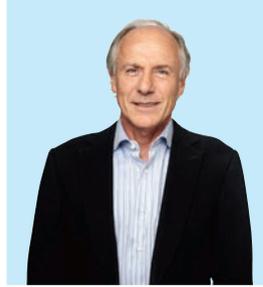


Cheryl Praeger
Mathematics



Huu Hao Ngo
Waste water

Foreword



As Australia's Chief Scientist I am privileged to chair the judging panel for the Prime Minister's Science Prize. Every year, we end up in the difficult position of having to pick the finalist from among several stunningly capable nominees. It's the kind of problem I love to have, and it reminds me every time what incredible talent lurks in Australia's research laboratories.

The challenge is to nurture the talent we have and to ensure the next generation of researchers is well educated and enters the workforce with high aspirations.

Aspirations soar when young people recognise that there are real-world problems waiting to be solved and that they can be part of the solution. They learn about these real-world problems from their parents and teachers, relatives, friends and stories. It is this last category in which this magazine makes an important contribution.

With their aspirations raised, young people have the confidence to try to solve real-world problems if they have a knowledge base on which to build. Hence my ongoing campaign to ensure that our young people are taught facilitating subjects at school and expected to do well. It is our duty to raise the bar of aspirations for young people, then coach them to leap over it.

Overall, we have been delivering. I am inspired, optimistic and honoured to witness the work produced by our researchers — whether it's the latest developments in space-based Earth observation technologies, improved cybersecurity algorithms or breakthroughs in my own field of neuroscience.

As a community we must set goals and be ambitious. The work currently underway on a national strategy for Australia to be a global leader in clean hydrogen production, export and use is an example of this approach. We are exploring options, researching capacity, understanding the parameters, defining what we do well, and mapping the best way to develop the sector.

The stories of the researchers featured in this magazine recognise the individual and combined achievements of our research sector, which in turn motivate others to strive for excellence, and show why our researchers are vital in supporting a strong economy, with benefits for all.

Dr Alan Finkel, AO
AUSTRALIA'S CHIEF SCIENTIST

THE AUSTRALIAN
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Best of the best

Young achievers, lifetime achievers and world-beating achievers — we identify the nation's leading researchers across more than 250 fields



From left: Paul McCarthy and Rasika Amarasiri

How to read the tables

There are four main types of tables in this magazine, each presenting different information about Australia's top researchers across more than 250 different fields of scholarship. The fields are divided into eight broad discipline areas.

World's best (Page 9): This list shows the 14 fields in which Australian-based researchers are the best in the world.

Lifetime achievers (Page 10): This list shows 40 top achievers over their research careers thus far. It lists a top five (not in order of achievement) in each of eight discipline areas: business, economics and management; social sciences; engineering and computer science; physics and mathematics; health and medical sciences; humanities, arts and literature; life sciences; and chemical and material sciences.

Because the lifetime achievers list measures

their cumulative research effort, researchers on this list have reached mid-career or beyond.

Field leaders: These listings, spread through these pages with one list for each of the eight discipline areas, are the heart of this magazine. Each of the eight research discipline areas is divided into research fields, and for each field we name Australia's leading researcher and their main institutional affiliation. We also name the leading research institution for each of the fields.

Early achievers (Page 54): This list shows 40 top early-career researchers and, like the lifetime achievers list, it names five researchers in each of the eight discipline areas named above. All of them are less than 10 years into their research careers, based on the date of their first citation.

For full details on how each list is calculated, see "How we did it", Page 58

Welcome to *The Australian's* 2019 *Research* magazine which, for the second year running, has dipped into the world of big data and drawn from it a unique and detailed picture of Australia's best research and the people who do it. We have taken advantage of the mass of information freely available online and, using the power of data analysis, have produced a list of our top researchers, and the top research institutions, in more than 250 fields of academic endeavour.

This is information you can't find anywhere else. And because it's a fine-grained view of research achievement, it allows excellence to be recognised which would otherwise not be noticed outside of a researcher's peer group.

It also identifies research excellence in places which are often overlooked. For example, Australia's top researcher in the field of audiology, speech and language pathology is Sharynne McLeod from Charles Sturt University. Of special note is that Professor McLeod, based in Bathurst in NSW, is not only at the top of her field in Australia, she's top of the world. In all, Australian-based researchers are first in the world in 14 fields of research.

We have also stepped back to look at the big picture, creating a leaderboard which honours 40 lifetime achievers in our universities and research institutions, and another leaderboard for the top 40 early career researchers, the ones who will lead the research achievements of the future.

All this is possible because of the work of pioneering research analytics firm League of Scholars, and its co-founders Paul McCarthy and Rasika Amarasiri, who have structured and filtered this information to bring it to life.

This year we have introduced something new, using the data to investigate not only which researchers are best in particular fields but who excels over many fields. The result is that we have named Australia's top interdisciplinary researcher on Page 40.

Our results are, of course, dependent on the data sources used (in our case Google Scholar) and the algorithms employed. We are very confident in them although we know improvements are possible. For example, people who have taken career breaks would find it harder to perform well on the measures we've used. We're looking at solutions for such issues.

But we also believe our approach has certain advantages over other approaches to measuring research impact. It is granular and able to identify performance in specialised fields. It gives more attention to humanities and social sciences than many other measures, and it's up to date. We hope it stimulates discussion and we welcome your feedback.

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Top of the world

These Australian-based researchers are the best in the world in their field based on the quality, volume and impact of their work

Field Asian Studies & History
Field leader Edward Aspinall
Institution Australian National University

Field International Law
Field leader Anthea Roberts
Institution Australian National University

Field Audiology, Speech & Language Pathology
Field leader Sharynne McLeod
Institution Charles Stuart University

Field Radar, Positioning & Navigation
Field leader Peter Teunissen
Institution Curtin University

Field Anesthesiology
Field leader Paul Myles
Institution Monash University

Field Automation & Control Theory
Field leader Peng Shi
Institution University of Adelaide

Field Computing Systems
Field leader Rajkumar Buyya
Institution University of Melbourne

Field Health & Medical Sciences (general)
Field leader Alan Lopez
Institution University of Melbourne

Field Ecology
Field leader Jane Elith
Institution University of Melbourne

Field Pest Control & Pesticides
Field leader Bhagirath Chauhan
Institution University of Queensland

Field Plant Pathology
Field leader Bhagirath Chauhan
Institution University of Queensland

Field Botany
Field leader Sergey Shabala
Institution University of Tasmania

Field Environmental Sciences
Field leader Huu Hao Ngo
Leading institution University of Technology Sydney

Field Higher Education
Field leader David Boud
Leading institution University of Technology Sydney



Sergey Shabala Plant physiologist, University of Tasmania Leading researcher in the world in the field of botany

Sergey Shabala pursues his pet topic with a relentless logic. Every minute, he says, three hectares of arable land are lost in Australia to the encroachment of salt. “I don’t see honestly that it will be changed or reversed,” he says. “So in 20 or 30 years from now agriculture will become saline agriculture.”

So for Professor Shabala there is only one way to go — find a way to make the plants used in agriculture more salt-resistant.

Interestingly, crops such as wheat, barley and rice were once more tolerant of salt. But when new high-yield varieties were developed in the 1960s — which led what we call the agricultural revolution, allowing the world to feed a larger population — some of this capacity was lost.

But now with salinity increasing, the miracle crops of 50 years ago are no longer performing so well. “Plants don’t respond as they are supposed to fertilisers any more because, under the stress conditions, their demands for nutrients and resources are different,” Professor Shabala says.

His answer is to step up research into wild crops to try to identify what they had which makes them more salt-tolerant.

“What we found is that the critical mechanism responsible for salt tolerance is the ability to accumulate and secrete salt in specialised structures,” he says. The structures are still present in modern varieties of wheat, barley and rice but they are no longer able to secrete the salt.

His solution is to look for wild genes which can be returned to modern crops to make them more efficient in acquiring nutrients under conditions of stress, whether that comes from salinity, too little water, too much water or the presence of pollutants such as heavy metals.

Professor Shabala doesn’t expect his work to pay off overnight. He thinks that practical applications are 10-15 years away.

And then he knows there will be a debate as to whether the community will accept lost wild genes being reinserted into the genomes of agricultural crops using genetic engineering techniques. Or whether scientists will have to do it the slow way by finding the gene in the wild and breeding it back in.

But of one thing he’s certain. “We need to make plants more robust in responding to stresses and extremes in climate,” he says.

TIM DODD

Lifetime Achievers Leaderboard

Stars of research

These are Australia's top 40 researchers. The five best performers have been selected from each of the eight main disciplines

Colour legend

- Business, Economics & Management
- Chemical & Material Sciences
- Engineering & Computer Science
- Health & Medical Sciences
- Humanities, Arts & Literature
- Life Sciences
- Physics & Mathematics
- Social Sciences



Paresh Narayan
International Business

At Deakin University, his research interests are applied financial econometrics, energy economics and financial markets



Benno Torgler
Economics

At Queensland University of Technology, his research interests include behavioural, experimental and non-market economics



Sara Dolnicar
Tourism

At the University of Queensland, her research interests are market segmentation methodology and testing survey measures in social sciences



Neal Ashkanasy
Human Resources

At the University of Queensland, his research interests are leadership, organisational culture, ethics and emotions in organisations



Jordan Louviere
Marketing

At the University of South Australia, he is an expert in conjoint analysis and consumer choice modelling



Shi Zhang Qiao
Materials Engineering

At the University of Adelaide, his research interests are synthesis and characterisation of nanomaterials



Yoshio Bando
Materials Engineering

At the University of Wollongong's Australian Institute for Innovative Materials, a leader in nanomaterials and electron microscopy



Yusuke Yamauchi
Chemical and Materials Science

At the University of Queensland, he researches design of nanocrystals and nanoporous materials



Dmitri Golberg
Materials Engineering

At Queensland University of Technology, his research interests include the fabrication of prototype photodetectors



Wang Guoxiu
Electrochemistry

At the University of Technology, Sydney, he is expert in materials chemistry, electrochemistry, and energy storage and conversion



Peng Shi
Automation and Control Theory

At the University of Adelaide, his research interests are systems and control theory, and computational intelligence



Rajkumar Buyya
Computing Systems

At the University of Melbourne, his research interests include the future of computing and large-scale software engineering



Dietmar Hutmacher
Biomedical Technology

At the Queensland University of Technology, his research interests are biomaterials, biomechanics, medical devices and tissue engineering



Qing-Long Han
Automation and Control Theory

At Swinburne University, his research interests include power system stability and control and wireless communication



Peter Love
Civil Engineering

At Curtin University, he researches building construction management and project planning, computer vision and construction engineering



James Sallis
Public Health

At the Australian Catholic University, his research includes promoting physical activity, sedentary behaviour, nutrition and obesity



Richard Ryan
Social Psychology

At the Australian Catholic University, his research interests include human motivation and personality development and well-being



Grant Montgomery
Genetics and Genomics

At the University of Queensland, his research interests include genomic mapping for risk of endometriosis and melanoma



Roy Baumeister
Social Psychology

At the University of Queensland, his research interests include willpower, self-control, self-esteem, human morality and success



Peter Visscher
Genetics and Genomics

At the University of Queensland, his research interests include understanding genes that underlie variation in risk to diseases



Axel Bruns
Communication

At the Queensland University of Technology, his research interests include social media, big data and online communities



Raewyn Connell
Gender Studies

At the University of Sydney, her research interests include social structures, inequalities and social justice



Jean Burgess
Communication

At the Queensland University of Technology, she researches social implications of digital media technologies, platforms and cultures



Alastair Pennycook
Foreign Language, Learning

At the University of Technology, Sydney, his research interests include implications of the global spread of English

Lifetime Achievers Leaderboard Stars of research



Adrian North
Music and Musicology

At Curtin University, his research interests include music and well-being in specific and general populations



Edward C Holmes
Virology

At the University of Sydney, his research interests include the emergence of novel viral infections



Ben Hayes
Animal Husbandry

At the University of Queensland, his research interests are genetic improvement of livestock, crop, pasture and aquaculture species



William Laurance
Biodiversity and Conservation Biology

At James Cook University, his research interests include impacts of intensive land-uses on tropical forests



Ove Hoegh-Guldberg
Marine Sciences and Fisheries

At the University of Queensland, his research interests include coral reefs, global warming and marine life



Joshua Cinner
Biodiversity and Conservation Biology

At James Cook University, his research interests include using social science to improve coral reef management



Ivo Labbé
Astronomy and Astrophysics

At Swinburne University, his research interests include the study of distant galaxies using big telescopes



Chunnong Zhao
High Energy and Nuclear Physics

At the University of Western Australia, his research interests are parametric instability and optomechanics



Christian Reichardt
Astronomy and Astrophysics

At the University of Melbourne, his research interests include cosmic microwave background and experimental astrophysics



Joss Bland-Hawthorn
Astronomy and Astrophysics

At the University of Sydney, his research interests include galactic archaeology and photonics



Dennis Stello
Astronomy and Astrophysics

At the University of NSW, his research interests include astroseismology, or analysing star quakes



Billie Giles-Corti
Public Health

At RMIT University, her research interests include the built environment's impact on health and wellbeing



Andrew Martin
Educational Psychology and Counselling

At the University of NSW, his research interests are educational motivation, engagement and achievement



Takemi Sugiyama
Public Health

At the Australian Catholic University, his research interests include the nexus between health and design



Rob Raven
Environmental Law and Policy

At Monash University, his research interests include the dynamics and governance of sustainability transitions and socio-technical innovation



David Treagust
Science and Engineering Education

At Curtin University, his research interests include how interventions can enhance understanding of science



Humanity is staring down some serious challenges that threaten our immediate and long-term sustainability. Lorenz’s “butterfly effect” analogy still applies, but the flap of a wing that causes the tornado is now a nebulous combination of social, political, environmental and economic factors that contribute to increasingly complex problems such as global food shortages, environmental change and unsustainable population growth — problems that can’t be solved by any institution, researcher or project alone.

The UN aims to redress this with its 17 sustainable development goals — urgent calls to action to address “wicked” global challenges that require diverse expertise and perspectives across multiple institutions, sectors and disciplines.

Universities, as the nexus of many of the world’s greatest minds, are uniquely positioned to be champions of achieving these goals. But creating change through research is (usually) not an isolated or spontaneous event. It requires co-ordination and collaboration — and having the right processes and mechanisms in place to facilitate the pathway from idea to impact is key.

The University of Queensland is one of Australia’s top research-intensive universities, not just for research quality and output, but also for the scale of our operations and breadth of our projects

UQ makes the right connections at the right time

across disciplines. Our reputation for creating change through research and commercialisation means we are a hub for curious minds who innovate and explore, and our strong focus on innovation-led entrepreneurship and commercialisation, facilitated largely by our commercialisation company UniQuest, ensures we have clear pathways to develop these ideas into real products and assets that create positive change.

While the scale, depth and breadth of our research capacity is an immense strength,

mobilising this effort requires significant institutional support in three key areas: people, infrastructure and networks.

Our focus on people not only involves attracting and retaining world leaders in different disciplines, but also nurturing talented early-career researchers to ensure a pipeline of talent. The business of doing research also requires continuous innovation, which is not possible without passionate research support professionals to seek out and maintain the best equipment and facilities, so recruiting and supporting career progression for these high-performing staff is also crucial.

Ensuring our research infrastructure is readily accessible is also vitally important. Our investment in world-class facilities and leading technologies allows our researchers to pursue their questions, and making such facilities available is one of the key ways universities can directly support innovation and impact.

But perhaps the most important piece of the puzzle on the pathway from idea to impact is facilitating collaboration and ensuring the right connections are made at the right time.

At UQ, this means encouraging and supporting our researchers to participate in global forums, industry roundtables and interdisciplinary projects, and entering into strategic partnerships with business, industry, government and community to share ideas, knowledge, facilities and talent.

We are also forming formal research networks that will bring together capabilities from across the whole university to intensify our research effort in five major global challenges: leading healthy lives, building better bioeconomies, achieving resilient environments and livelihoods, designing technology for tomorrow, and transforming societies.

For example, UQ’s world-leading research into new agrifood technologies is helping to build better bioeconomies and support sustainable livelihoods for our future.

By harnessing our research efforts and working with external partners and investors to co-design activities and projects in these five key areas, we are ideally placed to develop new ways of approaching these grand challenges and develop tangible solutions that will have an enduring impact in communities around the world.

research.uq.edu.au

Professor Bronwyn Harch
DEPUTY VICE-CHANCELLOR (RESEARCH)
AND VICE-PRESIDENT (RESEARCH)
THE UNIVERSITY OF QUEENSLAND

Business, Economics & Management

Australia's research field leaders

Field Accounting & Taxation

Field leader Lee Parker, RMIT

Leading institution RMIT

Field Business, Economics & Management (general)

Field leader Rob Hyndman, Monash

Leading institution Uni of Qld

Field Development Economics

Field leader Ben White, UWA

Leading institution Monash

Field Economic History

Field leader Lyndon Moore, Uni of Melb

Leading institution ANU

Field Economic Policy

Field leader Efrem Castelnuovo, Uni of Melb

Leading institution Monash

Field Economics

Field leader John Romalis, Uni of Sydney

Leading institution UNSW

Field Educational Administration

Field leader Tony Townsend, Griffith

Leading institution Deakin

Field Emergency Management

Field leader John Handmer, RMIT

Leading institution UTS

Field Entrepreneurship & Innovation

Field leader Per Davidsson, QUT

Leading institution QUT

Field Finance

Field leader Ronald Masulis, UNSW

Leading institution UNSW

Field Game Theory and Decision Science

Field leader Yves Zenou, Monash

Leading institution UNSW

Field Human Resources & Organisations

Field leader Neal Ashkanasy, Uni of QLD

Leading institution Monash

Field International Business

Field leader Paresh Narayan, Deakin

Leading institution Deakin

Field Marketing

Field leader Rebekah Russell-Bennett, QUT

Leading institution Uni of Wollongong

Field Strategic Management

Field leader Per Davidsson, QUT

Leading institution Uni of Wollongong

Field Tourism & Hospitality

Field leader Beverley Sparks, Griffith

Leading institution Griffith

In business, economics and management, our analysis finds that the top research talent, as well as occurring in the upper-tier Group of Eight universities, is also very strong in universities in the second tier.

In fact four universities outside the Group of Eight have achieved the double accolade of being home to the top researcher as well as being the top research institution in a particular field.

This usually indicates that there is a strong team operating in that area, not just a lone researcher of excellence.

For example RMIT University is both the top institution for accounting and taxation, and home to Lee Parker, the leading researcher in this field. Queensland University of Technology is top in entrepreneurship and innovation, where its faculty member Per Davidsson is the leading researcher. Griffith University leads in tourism and hospitality and its academic Beverley Sparks is the leading researcher. And Deakin University is top in international business, where its academic Paresh Narayan is the leading researcher.

Within the Group of Eight, institutions such as Monash University, UNSW, the University of Queensland and the University of Melbourne do well in this discipline. Outside it, the University of Wollongong deserves a special mention.

John Handmer Geographer RMIT University Research leader in the field of emergency management

John Handmer is the furthest thing from an ivory tower academic. In a country stricken by fires and floods, his work is deeply pragmatic. Professor Handmer researches the human side of disasters, examining

how governments and communities can prevent and recover from environmental emergencies.

Surprisingly, for somebody who is now at the top of his research field, he didn't appear to be headed for academic honours when he started university.

"My start in the academic scene wasn't very good," he admits, partly because he spent his time fixing motorcycles. "I actually made a bit of a living out of it. I suppose I was identified first as a motorcycle mechanic until I got my masters."

He eventually settled into the geography department at ANU, writing his honours thesis on flooding in coastal NSW, then left to continue his studies in Canada.

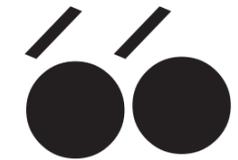
The intellectual atmosphere at the University of Toronto in the 1970s, at the peak of the environmental movement, was electric — especially in the department of geography.

"I went there from Canberra, which was a very quiet place, and it was like stepping into this seething torment of everything to

do with science, policy and environmental issues," he says.

He did his honours, masters and PhD in flood management, and turned towards fire management later in his career. He led research into the human cost of the tragic Black Saturday bushfires of 2009, remembered as some of Australia's worst fires of all time.

He comes into these scorched spaces with an analytical eye, so he doesn't find it as upsetting as some of his colleagues in hands-on roles, but he says it is increasingly



My start in the academic scene wasn't very good. I suppose I was identified first as a motorcycle mechanic until I got my masters

unsettling. "It's got more confronting over the years because I feel, sometimes, we should have learnt better."

Handmer's current area of research is aligning different global agreements on risk reduction, including the Sendai Framework for Disaster Risk Reduction, the Paris Agreement on climate change and the Sustainable Development Goals on everything from the end of poverty to the continuation of all life on Earth. These agreements all aim to promote equitable and sustainable social, economic and environmental development, largely through reducing risks. They overlap, but there are inconsistencies and contradictions.

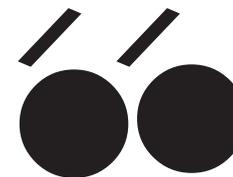
Working with the International Science Council, he is bringing together the common threads in each agreement to develop a more coherent policy response. One of the greatest challenges is managing "cascading and systemic risks": risks that build on each other and have the potential to cause the collapse of political, economic and social systems.

Addressing complex risks, Handmer says, requires us to recognise that "the explanations for disasters are found in the structures of society, the political, economic and social structures of society".

ZOE STOJANOVIC-HILL

AARON FRANCIS

Business, Economics & Management Australia's research field leaders



Biotech is an area with great innovations but they are not always taken up by doctors or patients. It can be about unfounded biases, inconvenience or fear

university and getting more people to donate blood.

She was recently named deputy director of a new research centre that combines behavioural economics and social marketing with biotechnology.

"Biotech is an area with great innovations but they are not always taken up by doctors or patients. It can be about unfounded biases, inconvenience or fear," Russell-Bennett says.

"Our work is helping people overcome those barriers without having to exert a great deal of effort."

Russell-Bennett and her colleagues were recently awarded best research paper at the 2019 World Social Marketing Conference. The paper looked at which marketing approach — a hug, nudge, smack or shove — was most effective around electricity usage?

The answer? "It depends on how critical the behaviour is. But if it's a crisis, no intervention works. You have to pull together as a community. It's about communication."

So G.D. Wiebe's question about brotherhood was well posed right from the outset.

JULIE HARE

Rebekah Russell-Bennett Social marketer, Queensland University of Technology Research leader in the field of marketing

Rebekah Russell-Bennett changes lives. She's not a doctor or a pastor or a philosopher or a yoga guru. No. Professor Russell-Bennett is a social marketer.

Social marketing — not to be mistaken for social media marketing — can be traced back to G.D. Wiebe, an Oxford academic in the 1950s who posed the question: "Why can't you sell brotherhood and rational thinking like you can sell soap?"

It's a good question.

In essence, social marketing is a field that looks at behavioural change, or as Russell-Bennett puts it: "It's about applying commercial marketing principles to helping people lose weight, save money and look after the environment."

The Queensland University of Technology professor takes a customer-centric approach to designing services that may be wildly different to what her clients — usually government departments or not-for-profits — think they want.

Take Breast Screen Queensland, which was typically failing to meet its annual target of screening 70 per cent of eligible women in the state. Russell-Bennett and her team were brought in to figure out why and find ways to improve rates.

"We looked at how you offer this service in a way that gets people to use it. It might be about changing the location, the opening hours, the decor, the messaging — instead of

scaring them about risk factors, maybe it's about peace of mind," she says.

As a result of their work, waiting rooms were made less clinical, opening hours increased and services moved out of hospitals and into shopping centres.

It worked.

As did the creation of a phone app to educate and encourage low-income people to use less electricity. People who engaged in the campaign saved on average 12 per cent or \$250 a year on their electricity bills.

Russell-Bennett has done work on condom usage in the over-50s, overcoming shame with breast feeding, encouraging financially disadvantaged people to go to

Melbourne's research partnerships underpin our water security

In 2007, the millennium drought was biting hard, irrigation communities were experiencing tough times and river ecosystems were in a dire state.

In response to this crisis, then prime minister John Howard announced the \$10 billion National Plan for Water Security. Addressing the National Press Club, Howard said: "The current trajectory of water use and management in Australia is not sustainable. In a protracted drought, and with the prospect of long-term climate change, we need radical and permanent change."

This policy direction was reaffirmed a year later by a Labor government, which relabelled the plan Water for the Future and increased the budget to \$13 billion.

After 12 years, good progress has been made in delivering these water reforms. This progress includes a Basin Plan which prescribes reduced limits on water use in the Murray-Darling Basin receiving bipartisan support in the federal parliament. These new limits are being implemented by state governments in their water resource plans. A large environmental water reserve has been established and delivered using active management to target environmental water at locations and times when it is needed by the environment. Environmental responses to these changes are generally of the type and magnitude expected at this stage of the plan. Investment in modern water supply technology has resulted in large improvements in efficiency and timeliness of irrigation supply to farmers and there have been significant gains in on-farm productivity.

However, public confidence in the commitment of governments to deliver the Basin Plan successfully has been undermined by several factors. There have been compliance issues where lax monitoring and enforcement have allowed some irrigators to extract water illegally. State governments have been slow in delivering elements of the agreed plan. Superficial and at times sensationalist media stories have invoked the name

of science to justify claims of the plan's failures.

These factors undermine water management arrangements and weaken the authority of the agencies involved. Action is being taken to restore the trust and integrity of basin water management arrangements, but this will take time.

Looking beyond these immediate implementation issues, three key challenges loom large in the Murray-Darling Basin. First, basin governments, cities, agricultural industries and regional communities need to plan for increasing climate extremes and diminished water availability including likely changes in land use, skills and technologies. Second, the grand project of restoring healthy rivers has commenced with the plan, but there is much more to be done to realise the full benefits from increased volumes of water reserved for the environment and investment in a range of complementary restoration measures. Finally, there is a long-standing need to allocate water rights to traditional owners for both cultural and economic use.

There is an urgent need to rebuild trust in our water management agencies so they can work effectively with each other and their stakeholders to address these emerging water security challenges. Partnerships between water researchers, government water agencies and water users can and should play a part in breaching the trust deficit. Water research collaborations have been a fundamental ingredient of Australia's water reform journey over the last 30 years. They provide a test bed for new thinking and an early warning system to prepare for crises before they occur.

Australia has a history of strong national research starting in the 1980s which informed successful water reforms including those mentioned above. However, while Australia's water research capability has been strong in the past, it has become severely fragmented with funding levels diminished to the lowest levels in 30 years. Collaborative partnerships take time and resources and they decline when funding is diminished. A new national

platform and vision for funding and co-ordinating water R&D is sorely needed.

With these challenges in mind, the University of Melbourne, La Trobe University and Sunraysia TAFE have partnered to establish the Mallee Regional Innovation Centre. Access to water research capabilities is vital in arid regions like the Mallee in Victoria's northeast, with a high level of exposure to variations in water availability. Funded by Regional Development Victoria, the new centre provides cross-sectoral R&D capability in the region. Projects are focusing on the need for technology innovation in horticulture but with an eye to the broader challenge of planning a water-secure future for the region. A leader in place-based research linked to state and national policy institutions, the centre is a model for building basin-wide collaborations to tackle Australia's big water policy challenges.

In 2007, when Howard announced the National Plan for Water Security, he referred to himself as a "climate-change realist". He described this as "looking at the evidence as it emerges and responding with policies that preserve Australia's competitiveness and play to our strengths".

A strong culture of research-industry partnership which provides evidence for policy formation should be an important pillar of our water security. However, this will require a national effort to rebuild water R&D partnerships and the research capability to support this.

Professor Michael Stewardson

LEADER, WATER, ENVIRONMENT AND AGRICULTURE PROGRAM
DIRECTOR, MALLEE REGIONAL INNOVATION CENTRE
MEMBER OF THE ADVISORY COMMITTEE ON SOCIAL ECONOMIC AND ENVIRONMENTAL SCIENCE FOR THE MDBA
THE UNIVERSITY OF MELBOURNE

Social Sciences

Australia's research field leaders

Field Academic & Psychological Testing
Field leader David Boud, UTS
Lead institution Uni of Qld

Field Anthropology
Field leader Zenobia Jacobs, Uni of Wollongong
Lead institution ANU

Field Archaeology
Field leader Chris Turney, UNSW
Lead institution ANU

Field Cognitive Science
Field leader Scott Brown, Uni of Newcastle
Lead institution Uni of Melb

Field Criminology, Criminal Law & Policing
Field leader Lorraine Mazerolle, Uni of Qld
Lead institution Griffith

Field Diplomacy & International Relations
Field leader Roberto Foa, Uni of Melb
Lead institution Uni of Melb

Field Early Childhood Education
Field leader Rauno Parrila, Macquarie
Lead institution Griffith

Field Education
Field leader Herbert Marsh, ACU
Lead institution Griffith

Field Educational Psychology & Counselling
Field leader Andrew Martin, UNSW
Lead institution UNSW

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

Field Environmental & Occupational Medicine
Field leader Anthony Lamontagne, Deakin
Lead institution Monash

Field Environmental Law & Policy
Field leader Rosemary Hill, CSIRO
Lead institution UWA

Field Ethics
Field leader Chris Mason, Swinburne
Lead institution Monash

Field European Law
Field leader Adrienne Stone, Uni of Melb
Lead institution Monash

Field Family Studies
Field leader Matthew Sanders, Uni of Qld
Lead institution Uni of Qld

Field Forensic Science
Field leader Duncan Taylor, SARDI
Lead institution UTS

Field Geography & Cartography
Field leader Richard Howitt, Macquarie
Lead institution Uni of Melb

Field Health Policy & Medical Law
Field leader Adrian Bauman, Uni of Sydney
Lead institution Uni of Sydney

Field Higher Education
Field leader David Boud, UTS
Lead institution Monash

Field Human Migration
Field leader Raelene Wilding, La Trobe
Lead institution Deakin

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

Field Law
Field leader Anthea Roberts, ANU
Lead institution ANU

Field Military Studies
Field leader Sarah Percy, Uni of Qld
Lead institution RMIT

Field Political Science
Field leader Roberto Foa, Uni of Melb
Lead institution Uni of Melb

Field Public Health
Field leader Adrian Bauman, Uni of Sydney
Lead institution Uni of Sydney

Field Public Policy & Administration
Field leader Brian Head, Uni of Qld
Lead institution Uni of Canberra

Field Science & Engineering Education
Field leader Lambert Schuwirth, Flinders
Lead institution Deakin

Field Social Sciences (general)
Field leader John Handmer, RMIT
Lead institution CSIRO

Field Social Work
Field leader Matthew Sanders, Uni of Qld
Lead institution Griffith

Field Sociology
Field leader Garry Robins, Uni of Melb
Lead institution WSU

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

Field Teaching & Teacher Education
Field leader Christine Edwards-Groves, CSU
Lead institution UTS

Field Technology Law
Field leader Dan Svantesson, Bond
Lead institution Griffith

Field Urban Studies & Planning
Field leader Jason Byrne, Uni of Tasmania
Lead institution Uni of Melb

S

ocial science is a discipline which is treated well by the methodology we use in this magazine. Google Scholar, our data source for publications and citations, includes more social sciences research than traditional sources do.

It is an area in which Australia produces global research leaders. The Australian National

University's Anthea Roberts is number one in the world in international law, and David Boud, from the University of Technology Sydney, is the world leader in the higher education research field.

It's also a discipline where universities that are not national leaders in research overall have their turn in the spotlight for being outstanding in specific areas. For example, Lambert Schuwirth from Flinders University is the Australian leader in the field of science and engineering education, Christine Edwards-Groves from Charles Sturt University is the leader in teaching and teacher education, and Western Sydney University is Australia's leading institution in the field of sociology.

The social sciences are also a highly varied discipline, ranging from ethics where Swinburne University's Chris Mason is the leading researcher to military studies where the University of Queensland's Sarah Percy leads.



Andrew Martin
Educational psychologist, UNSW
Leader in the field of educational psychology & counselling

Andrew Martin's career as an educational psychologist has been built on a simple question. The UNSW professor asks: "If you boil it down — the last 25-plus years of research — what are the factors and processes that switch kids on and switch kids off?"

It's a simple question, but extracting answers that improve the lives of disengaged students, and discouraged and frustrated teachers, is complicated. Yet great headway has been made.

Martin's most cited paper, published a decade ago, concluded that a major clue lay in what he calls "relatedness".

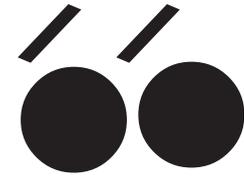
"That paper looked at all the major educational psychology theories," he says. "And in every one of them, without fail, a powerful issue was students connecting to someone — parents, peers or teachers. What is almost not negotiable is a teacher getting on with the students.

"That article has become the

most cited because it has a lot of practical implications. It's one thing to recognise something — most people will do that — but to operationalise it into the everyday pedagogy? That's hard."

He developed a strategy known as "connective instruction", so teachers can aim for what he calls the sweet spot of the optimal, "authoritative" teaching style, avoiding the excesses of being authoritarian or permissive.

Another challenge is



It's one thing to recognise something — most people will do that — but to operationalise it into the everyday pedagogy? That's hard

establishing a productive relationship with every child in a class they may meet as few as three times a week for as little as 40 minutes at a time. "And at the same time teach them photosynthesis!"

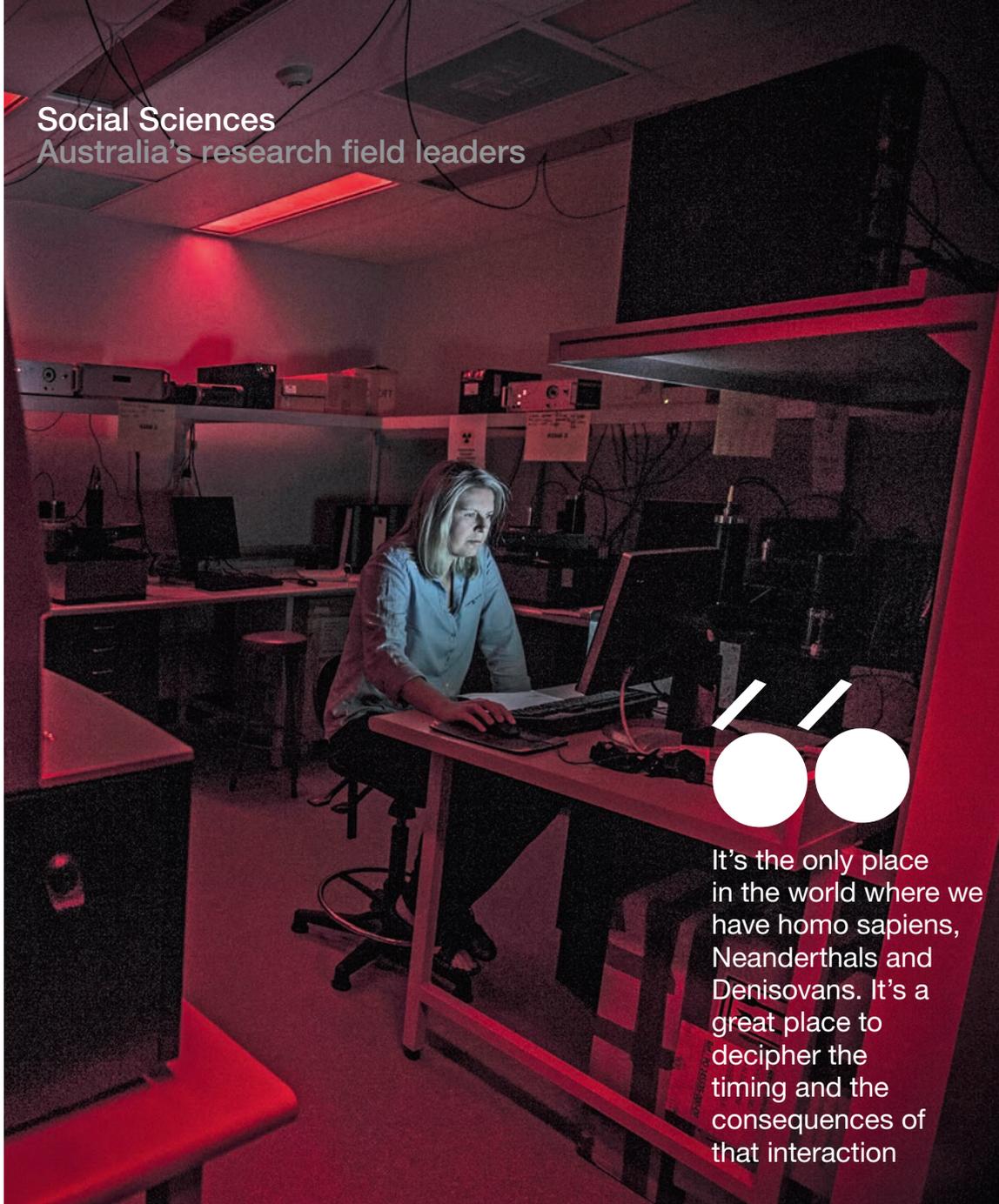
With UNSW colleague, psychology professor Joel Pearson, Professor Martin is measuring students' biometric data to see how they learn and engage. The project, funded by an Australian Research Council grant in collaboration with Sydney's The King's School but involving other schools too, will involve more than 500 students.

"Most of our research has been based on student self-reporting. Now we want to capture additional information. So we're putting neuro headsets and biometric wristbands on kids in classrooms, measuring their biomarkers while they're completing a task and asking them to self-report how motivated they were during the task," he says.

"We are especially interested in the links between, for example, their brain signals and the motivation they show in the tasks. We're still at the measurement phase, trying to disentangle what signals are true and really are reflecting motivation and what signals are noise."

JILL ROWBOTHAM

Social Sciences Australia's research field leaders



It's the only place in the world where we have homo sapiens, Neanderthals and Denisovans. It's a great place to decipher the timing and the consequences of that interaction

300,000 years ago. Denisovans, a human-related species which were discovered in the cave and named after it, have been there since at least 210,000 years ago and as recently as 60,000 years ago.

Neanderthals, another species related to humans, were definitely in the cave about 130,000 years ago. Pendants, bone tools and other paraphernalia associated with modern humans have also been found in Denisova Cave, making it one of the richest and most interesting sites in the world for studying early humans.

"It's the only place in the world where we have homo sapiens, Neanderthals and Denisovans. It's a great place to try and decipher the timing and the consequences of that interaction," she said.

Professor Jacobs dates the layers of sediment in the cave by measuring the effect of the background radioactivity on the sand grains. It tells her when the sand was last exposed to sunlight, which is also the time when the bones and artifacts found in the sediment were laid down.

Her goal is to build an accurate timeline for humans and human-related species in the area over the past 800,000 years. She works with other researchers including teams from the Russian Academy of Sciences and specialists in ancient genetics from the Max Planck Institute in Germany.

It is painstaking work. Different types of minerals react differently to the background radio activity so everything must be carefully calibrated. She says that a paper published in *Nature* this year was the result of five years spent working out how to date the sample, and then two more years spent dating it.

"These are really long-term projects ... to understand the story behind homonin interaction and migration," she says.

TIM DODD

Zenobia Jacobs Archeological scientist, University of Wollongong Research leader in the field of anthropology

Zenobia Jacobs, one of the world's leading experts in dating archeological sites, asks herself the big questions. How did our species, homo sapiens, come to be? Why do we behave the way we do? Why are we the only ones left of the many species that were closely related to humans

that we know once existed? What gave us an edge that species such as Neanderthals and others did not have?

Through her work, Jacobs tries to answer those questions. She's an expert in using optically stimulated luminescence dating, a method that is capable in the best

conditions of dating archeological sites as far back as 800,000 years, a time before homo sapiens existed (as far as we know).

Each year she makes a research trip to the famous Denisova Cave in Siberia, where homonins, or early humans, are known to have lived since at least

Engineering & Computer Science

Australia's research field leaders

This discipline combines the old and the new: the traditional engineering fields such as civil, mechanical and structural; as well as brand new types of engineering and the ever-expanding cutting edge fields, such as fuzzy systems and human computer interaction, which relate to computer science.

It is also a discipline in which universities have strong research teams, as evidenced by the fact that in 16 of the 43 separate research fields, the same university is both the top research institution and has the top researcher.

The University of Adelaide's Peng Shi is a star, leading the nation in both automation and control theory (in which he also leads the world) and in fuzzy systems. Adelaide is also Australia's leading research institution in both these areas.

As would be expected, both the Group of Eight universities and technology universities do well in this discipline. But in specific fields, other institutions also shine. The University of Tasmania is the leading institution in ocean and marine engineering and Deakin University holds a leading position in textile engineering, where it also hosts the leading researcher, Lu Sun.

Another worthy mention is Paul Salmon, Australia's leading researcher in quality and reliability, who is from the University of the Sunshine Coast.

Field Architecture
Field leader Santamouris Mat, UNSW
Leading institution Uni of Newcastle

Field Artificial Intelligence
Field leader Peng Shi, Uni of Adelaide
Leading institution Uni of Adelaide

Field Automation & Control Theory
Field leader Peng Shi, Uni of Adelaide
Leading institution Uni of Adelaide

Field Aviation & Aerospace Engineering
Field leader Richard Sandberg, Uni of Melb
Leading institution RMIT

Field Bioinformatics & Computational Biology
Field leader Torsten Seemann, Uni of Melb
Leading institution Monash

Field Biomedical Technology
Field leader Yin Xiao, QUT
Leading institution QUT

Field Biotechnology
Field leader Huu Hao Ngo, UTS
Leading institution UTS

Field Civil Engineering
Field leader Togay Ozbakkaloglu, Uni of Adelaide
Leading institution Monash

Field Computational Linguistics
Field leader Timothy Baldwin, Uni of Melb
Leading institution Uni of Melb

Field Computer Graphics
Field leader Tim Dwyer, Monash
Leading institution Monash

Field Computer Hardware Design
Field leader Yang Xiang, Swinburne
Leading institution Uni of Adelaide

Field Computer Networks & Wireless Communication
Field leader Stephen Hanly, Macquarie
Leading institution UNSW

Field Computer Security & Cryptography
Field leader Willy Susilo, Uni of Wollongong
Leading institution Uni of Wollongong

Field Computer Vision & Pattern Recognition
Field leader Anton Van Den Hengel, Uni of Adelaide
Leading institution Uni of Adelaide

Field Computing Systems
Field leader Rajkumar Buyya, Uni of Melb
Leading institution Uni of Sydney

Field Data Mining & Analysis
Field leader Xiaofang Zhou, Uni of Qld
Leading institution UNSW

Field Databases & Information Systems
Field leader Anthony Dick, Uni of Adelaide
Leading institution UNSW

Field Engineering & Computer Science (general)
Field leader Peter Skands, Monash
Leading institution Swinburne

Field Evolutionary Computation
Field leader Morteza Saberi, UNSW
Leading institution Uni of Adelaide

Field Fuzzy Systems
Field leader Peng Shi, Uni of Adelaide
Leading institution Uni of Adelaide

Field Human Computer Interaction
Field leader Gelareh Mohammadi, UNSW
Leading institution Uni of Melb

Field Information Theory
Field leader Min-Hsiu Hsieh, UTS
Leading institution UTS

Field Library & Information Science
Field leader Hamid R Jamali, CSU
Leading institution RMIT

Field Manufacturing & Machinery
Field leader Huijun Li, Uni of Wollongong
Leading institution Monash

Huu Hao Ngo

Environmental engineer

University of Technology Sydney

Research leader in the field of biotechnology

Recycling urban waste water efficiently and effectively is a complex mission, but in a world concerned about its most precious resource and a country regularly in drought, Huu Hao Ngo is leading and collaborating on cutting-edge research to eliminate the challenges.

Ngo, an environmental engineer and deputy director of the UTS Centre for Technology in Water and Waste Water, ranges widely in his research.

One outstanding example is the development of GemFloc bioflocculant, a green material that can minimise membrane fouling and maximise the performance of membrane bioreactors for the best quality of recycled water.

Ngo jointly holds the patent and after seven years of work, Gemfloc is now the subject of large-scale trials in Xi'an in central China. An investment of about \$60,000 from the university in the project has brought a return of \$250,000 so far.

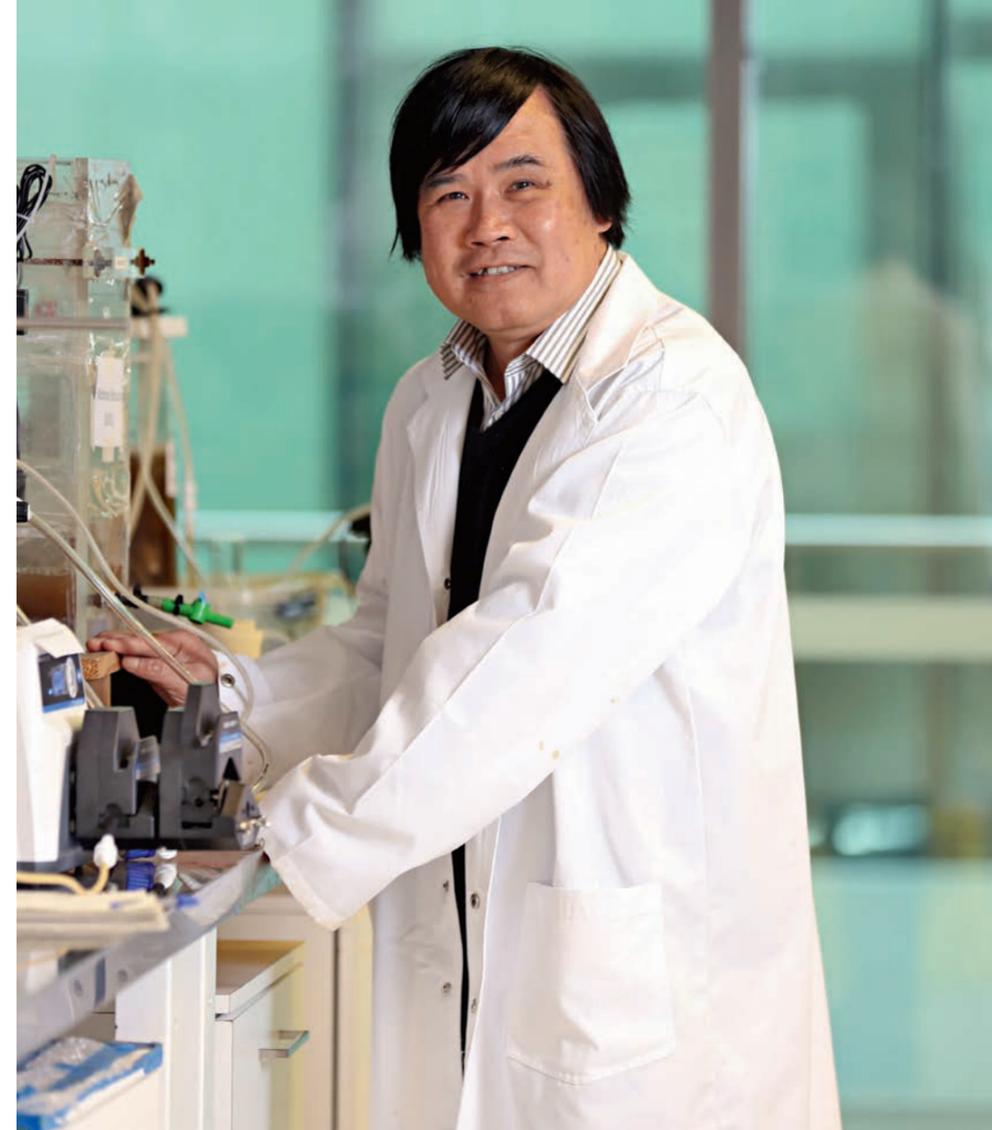
Ngo grew up in what was then South Vietnam during the Vietnam War. He left and took his early degrees in agricultural engineering at the National University of Taiwan, intending to return home and make a contribution there.

When Saigon fell in 1975 almost all of his family became part of the Vietnamese diaspora, with most of them heading to the US.

Ngo, still in Taiwan, chose Australia as offering the best education for his twin daughters, and the family emigrated in 1987.

It was at UTS that he tackled his

JANE DEMPSTER



PhD while working fulltime to support his family, devising a personal philosophy he calls "DIPP" to help him embrace the unrelenting hard work without becoming overwhelmed.

"I had to find a way that I could enjoy it," Ngo says. "I require myself to maintain four key factors: dedication, inspiration, passion and persistence.

"In addition, music, arts and cute things, especially Winnie the Pooh, do make me become a happy researcher with rich ideas."

Ngo knew that for his work to have global impact he would have to produce some attention-getting papers.



Music, arts and cute things, especially Winnie the Pooh, do make me become a happy researcher with rich ideas

The key to his strategy, he says, is "knowing how to select hot topics".

Other elements are: to repeatedly revise articles until satisfied as to their excellence; to choose high-impact journals to approach for publication; to work with high-quality collaborators; and to be an active and leading member in the global network of scholars in his field through editing top journals and reviewing the papers of others.

Finally, he adds, almost as an afterthought, part of his success is "being lead researcher in the field".

JILL ROWBOTHAM

Field Mechanical Engineering
Field leader Jie Yang, RMIT
Leading institution RMIT

Field Medical Informatics
Field leader Johanna Westbrook, Macquarie
Leading institution Uni of Qld

Field Metallurgy
Field leader Huijun Li, Uni of Wollongong
Leading institution Monash

Field Microelectronics & Electronic Packaging
Field leader Karu Esselle, Macquarie
Leading institution Griffith

Field Mining & Mineral Resources
Field leader Zhao Jian, Monash
Leading institution Curtin

Field Multimedia
Field leader Helen Huang, Uni of Qld
Leading institution Uni of Qld

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

Field Operations Research
Field leader Daniel Prajogo, Monash
Leading institution Uni of Sydney

Field Power Engineering
Field leader Zhaoyang Dong, UNSW
Leading institution UNSW

Field Quality & Reliability
Field leader Paul Salmon, USC
Leading institution RMIT

Field Radar, Positioning & Navigation
Field leader Peter Teunissen, Curtin
Leading institution Curtin

Field Remote Sensing
Field leader Jeffrey Walker, Monash
Leading institution Monash

Field Robotics
Field leader Michael Milford, QUT
Leading institution Uni of Wollongong

Field Signal Processing
Field leader Ba Tuong Vo, Curtin
Leading institution Uni of Sydney

Field Software Systems
Field leader Tsong Yueh Chen, Swinburne
Leading institution Monash

Field Structural Engineering
Field leader Xiao-Ling Zhao, Monash
Leading institution UNSW

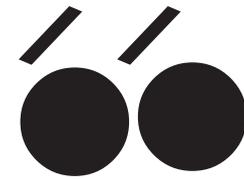
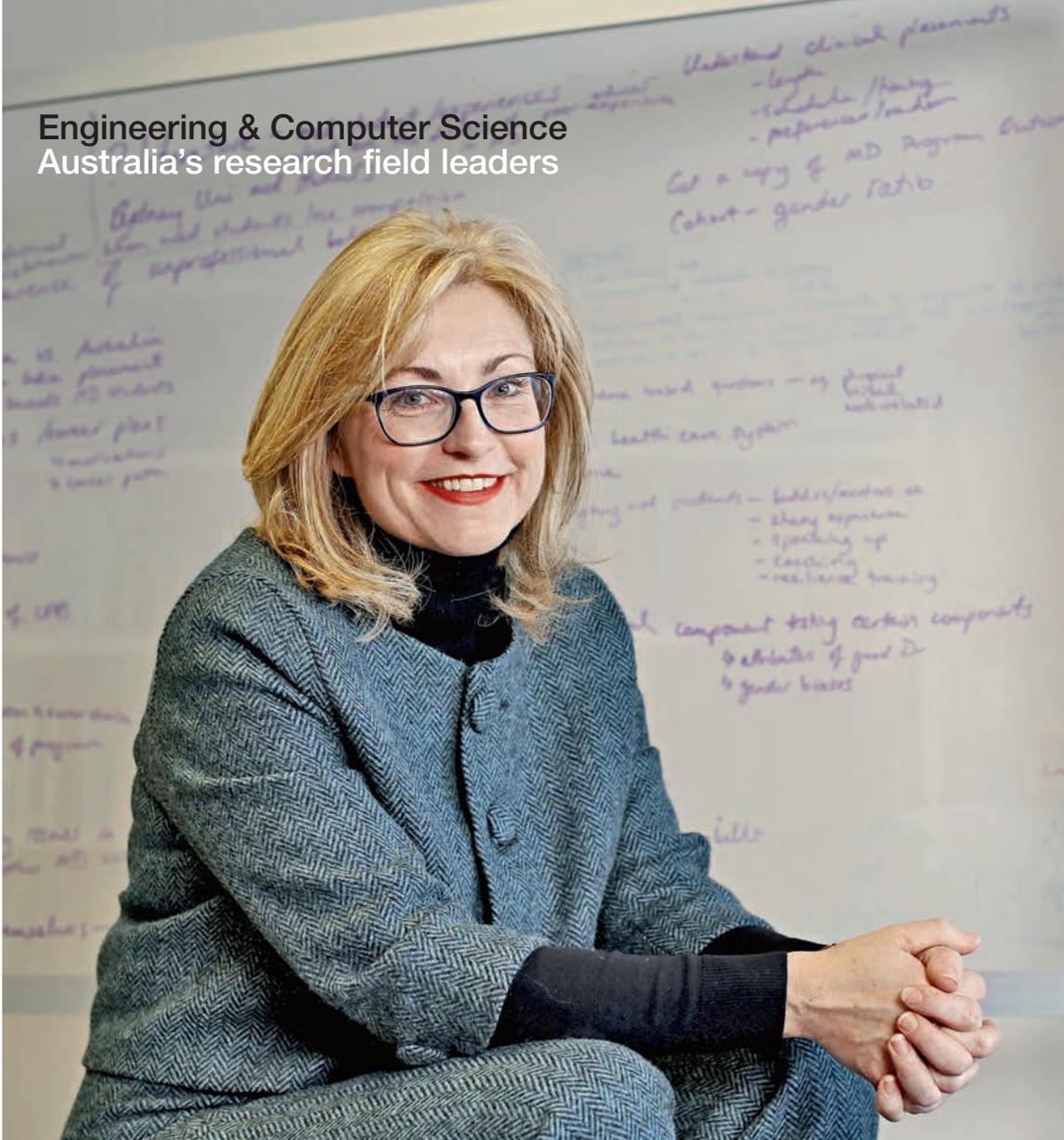
Field Textile Engineering
Field leader Lu Sun, Deakin
Leading institution Deakin

Field Theoretical Computer Science
Field leader Jinjun Chen, Swinburne
Leading institution Swinburne

Field Transportation
Field leader Simon Washington, Uni of Qld
Leading institution Uni of Sydney

Field Water Supply & Treatment
Field leader Tony Fane, UNSW
Leading institution UTS

Engineering & Computer Science
Australia's research field leaders



A number of studies had measured the frequency of interruptions but never linked interruptions to an outcome, because methodologically it's quite challenging

Westbrook's research is diverse and prolific (34 papers so far this year) but her work on aged care is special to her. She told the Royal Commission into Aged Care Quality and Safety in June that the aged care sector was "data rich but information poor". A number of her papers have studied medication patterns in residential aged care facilities and quality of life for people receiving community care services.

"That's probably been one of the most rewarding areas of research because of the feedback that we have received from clients and caseworkers who are using tools to ask people about their quality of life," she says.

"People are saying 'no one's ever asked these questions before!'"

She values citation indices as helpful in tracking others in her field. "The world is a big place and it's very easy to send these research papers out there but you don't know who's reading them or what they are doing with them," Professor Westbrook says. "For example, the wombat methodology is being used in a whole range of different areas, such as hand hygiene in Zanzibar."

JILL ROWBOTHAM

Johanna Westbrook
Health data researcher, Macquarie University
Research leader in the field of medical informatics

When Johanna Westbrook developed an interest in what is now called medical informatics as a school leaver in the late 1980s, paper records and early computer systems were the norm in hospitals.

By the time she became quality manager at Sydney's St Vincent's Hospital, in her mid-20s, she determined there must be ways to collect and crunch data that would yield information to improve patient care and safety, as well as to devise evidence-based methods

to lift efficiency and professionalism in the health workforce.

Westbrook now leads a team of 40 as director of the Centre for Health Systems and Safety Research at Macquarie University's Australian Institute of Health Innovation.

Her most cited paper investigates "whether there was an association between nurses being interrupted while they undertake medication administration and the errors they made".

"A number of studies had

measured the frequency of interruptions but never linked interruptions to an outcome, because methodologically it's quite challenging to do that," Westbrook says.

In 2009 she and her team published their Work Observation Method by Activity Timing, a means of measuring clinicians' patterns of work and communication. The "wombat" method has since been used by more than 30 teams in 12 countries to improve work patterns, safety and outcomes.

NIKKI SHORT

Southern Cross tackles the big-picture problems



The wicked challenges facing our planet and our communities demand a different way of thinking. We should not shy away from the complexities of climate change, nor the challenges of environmental degradation and the impact human activity has on ecosystems.

Because there is hope.

It is a hope inspired by the very real action of teams of researchers threading together a collective understanding that is making substantial contributions to saving the planet. Southern Cross University is a global leader in many of these areas.

We're proud to be a partner in initiatives such as the United Nations Decade of Ocean Science for Sustainable Development, and in delivering the "Our Coast Futures" global conference in October 2020 at our beachside Gold Coast campus.

But those initiatives are driven by a deep and long-term commitment to tackling the big issues such as saving the Great Barrier Reef, managing greenhouse emissions and pursuing genuine partnerships to achieve those goals.

For instance, ecology and technology are combined in a world first to give nature a helping hand, using an underwater robot to deliver millions of coral larvae directly onto the Great Barrier Reef and on degraded reefs in the Philippines in the pilot of a new technique to help restore and recover coral reefs. It was recently featured on the BBC's *Blue Planet Live* program, broadcast globally.

That work was led, and continues to be led, by Southern Cross University's Professor Peter Harrison and QUT's Professor Matthew Dunbabin.

The project builds on Professor Harrison's successful larval reseeding technique piloted in the Philippines with researchers from the University of the Philippines, and on the southern Great Barrier Reef in 2016 and 2017 in collaboration with the Great Barrier Reef Foundation, the Great Barrier Reef Marine Park Authority and Queensland Parks & Wildlife Service.

This is research that can help save Australia's greatest natural wonder. It is inspiring and has inspired other researchers at Southern Cross to research the impact of mercury and other metal mining contamination on reefs, as well as other environmental factors such as run-off from farming and industry and the adaption of corals to different environments to better understand coral bleaching.

The western Pacific region, known as the Coral Triangle, is hailed as the epicentre of the world's coral reef biodiversity, and it is here that Southern Cross University's Associate Professor Amanda Reichelt-Brushett is negotiating a delicate balance of culture, economy, industry and the environment.

Comprising territorial waters of Indonesia, Malaysia, the Philippines, Papua New Guinea, Timor-Leste and the Solomon Islands, the richness of the Coral Triangle is a marine marvel.

But riches also exist on the land, driving an economic gold rush for regional communities

through small-scale gold mining.

With Australian Research Council funding and regional partnerships, Professor Reichelt-Brushett's research is highlighting the environmental impact of mercury contamination from mining.

The ramifications are clear. Small-scale gold mining using mercury is practised by an estimated 50 million people globally, including in many regions of the Asia-Pacific. The transformation of elemental mercury into the more poisonous methylmercury creates an increasing risk of contaminated ecosystems and fisheries. Health problems can also arise, both for people eating contaminated seafood and for the marine environment itself.

Professor Reichelt-Brushett's research in collaboration with the University of Pattimura in Indonesia is helping find solutions to this problem.

And while the big picture looks at entire ecosystems, the behaviour of individual species is just as important.

Southern Cross University marine scientist Professor Kirsten Benkendorff is leading research into the impact of pesticides, both entrenched and emerging. Of particular interest is the effect of neonicotinoids, which are banned in some countries, though not Australia.

They find their way into our rivers and estuaries and can damage and potentially wipe out species.

In the case of prawns and oysters, pesticides can absorb into their flesh at higher than the maximum tolerable limits for food. This presents a risk to both consumer health and seafood organisms.

Professor Benkendorff's work has identified that seafood populations are showing stress from pollution and climate change, and she is looking at strategies for improving long-term health and productivity. Collaborations with groups such as Ozfish, Ridley and the Department of Primary Industries are bringing scientific data to bear on resource protection, restoration and sustainability.

These projects are just a snapshot of the solutions-driven research undertaken at Southern Cross University. They focus on marine and environmental issues, often interlinked with the communities and the societies of the region in question.

It is not abstract. It is right here, right now, working genuinely and in collaboration with people all over the world to solve the big problems facing us all. That is research at its best.

Professor Mary Spongberg
DEPUTY VICE-CHANCELLOR (RESEARCH)
SOUTHERN CROSS UNIVERSITY

Physics & Mathematics

Australia's research field leaders

Traditionally it's the Group of Eight universities which do well in this area, particularly due to the expense of the equipment used in physics and the fact that a quality mathematics department is something on which every leading research university prides itself.

But while the Group of Eight is well represented, the University of Technology Sydney is the leader in both mathematical optimisation and electromagnetism, the University of Wollongong is the leader in algebra and the University of New England is the leader in mathematical analysis.

Field Acoustics & Sound
Field leader Xiaojun Qiu, UTS
Leading institution UNSW

Field Algebra
Field leader Cheryl Praeger, UWA
Leading institution Uni of Wollongong

Field Astronomy & Astrophysics
Field leader Joss Bland-Hawthorn, Uni of Sydney
Leading institution Uni of Sydney

Field Biophysics
Field leader David Lloyd, Griffith
Leading institution Monash

Field Computational Mathematics
Field leader Fawang Liu, QUT
Leading institution UNSW

Field Condensed Matter Physics & Semiconductors
Field leader Lingqing Wen, UWA
Leading institution UTS

Field Discrete Mathematics
Field leader Nicholas Wormald, Monash
Leading institution Monash

Field Electromagnetism
Field leader Karu Esselle, Macquarie
Leading institution UTS

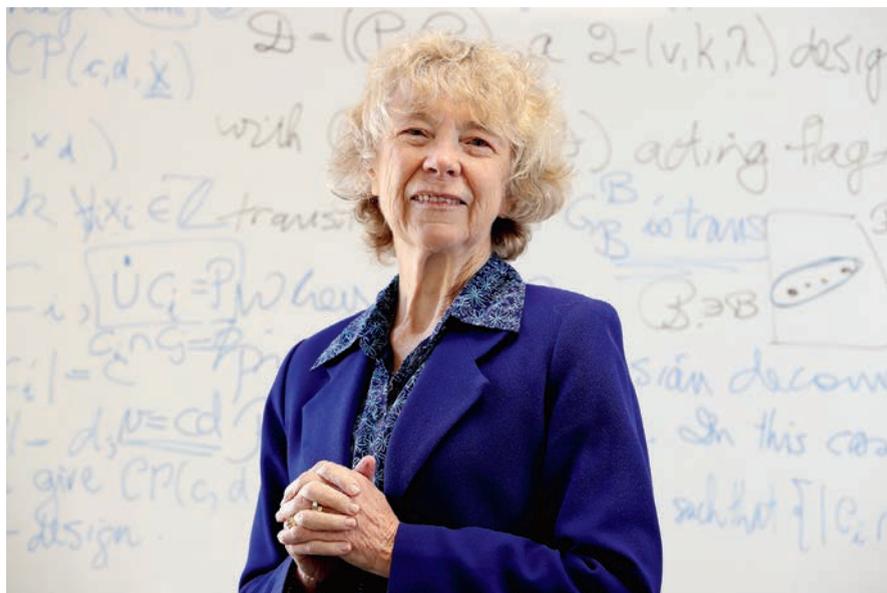
Field Fluid Mechanics
Field leader Ivan Marusic, Uni of Melb
Leading institution Uni of Melb

Field Geometry
Field leader Diarmuid Crowley, Uni of Melb
Leading institution Monash

Field Geophysics
Field leader Pep Canadell, CSIRO
Leading institution Curtin

Field High Energy & Nuclear Physics
Field leader Bruce Yabsley, Uni of Sydney
Leading institution Uni of Sydney

Field Mathematical Analysis
Field leader Yihong Du, UNE
Leading institution UNE



Cheryl Praeger

Mathematician

University of Western Australia

Research leader in the field of algebra

Cheryl Praeger has an alphabet-long list of letters after her name including five honorary doctorates from universities flung far across the world — Iran, Thailand, Belgium, Scotland and Slovenia. They are a testament both to her stellar contribution to mathematical theory and her dedication to helping the careers of mathematicians from less fortunate backgrounds than her own.

Mathematics has delivered the humble Toowoomba-born mathematician a life lived on a large scale. Defying careers advice to become a nurse, or maybe a teacher, Praeger stubbornly stuck with her passion and headed to the University of Queensland to study mathematics before being awarded a Commonwealth scholarship to do her PhD at Oxford.

Her precise contribution to the field of mathematics is hard to pin down, so prodigious is her research output and so catholic are her interests.

Much of her research has focused on the theory of group actions and their applications in algebraic graph theory and to combinatorial designs. She's also interested in algorithms for group computation including questions in statistical group theory and algorithmic complexity.

She has published more than 400 journal papers — including three on the mathematics of weaving and how fabrics hang together — and five books.

"Maths is absolutely creative," she says. "It comes through creating whole systems

Continued next page



Joss Bland-Hawthorn
Galactic archaeologist, University of Sydney
Research leader in the field of astronomy
& astrophysics

Joss Bland-Hawthorn had a revelatory experience when he was a boy of about 12. Somebody told him that the Milky Way — the line of stars we see across the night sky — was evidence that we lived in a flat galaxy rather than a spherical one. The reason being that, if it was spherical, we would see a lot of stars around us in all directions.

“I just thought it was incredible that you can learn about massive scales just by being on this little planet. And that was the beginning of a journey of trying to understand more about the universe,” Bland-Hawthorn says.

That intense fascination eventually led him, in collaboration with astronomer Ken Freeman at the Australian National University, to develop the field of galactic archaeology. They dug down to discover the past, not with tools removing layers of dirt, but with telescopes that made individual observations of the millions of stars in our galaxy.

It was only possible to do this because of an Australian innovation, now used world-wide, which used optical fibre technology to allow one telescope to record data from hundreds of stars at once. “You can get through a million stars in a couple years,” Bland-Hawthorn says.

From the position and motion of each star, its orbit around the galactic centre could be calculated. The chemical composition of each star (revealed by the wavelengths of light it emitted) showed when, in the history of the universe, it was formed. Slowly but surely theories about the history of the galaxy emerged.

He and Freeman were not the first to build a picture of the galaxy by cataloguing the velocity and type of its constituent stars, but they took it further. “What Ken and I did in 2000 was package those ideas into a way of thinking much more broadly about how the galaxy formed,” Bland-Hawthorn says.

He was also a pioneer in applying the new science of photonics to make telescopes more effective. With colleagues Sergio Leon-Saval and Tim Birks, he invented the photonic lantern, which could “clean up” the light collected by telescopes. Just like wifi, which was invented by radio astronomers trying to make sense of weak signals, Bland-Hawthorn’s photonic lantern has also jumped the barrier between pure science and important commercial applications.

TIM DODD

Continued from previous page

and theories, and sometimes they only make sense if you have the structures. You have to find these new structures. To understand viruses, for example, and how they propagate, is through the mathematics of symmetry, which is my thing. It’s quite visual.”

Indeed, mathematical problems present themselves to Praeger as pictures.

“I have to draw pictures in my mind and the logical sequence is incredibly stressful if I’m trying to sleep,” she explains. “Occasionally I see everything falling into place and then I have to get up and write it down or I’ll miss some steps the next day.”

Praeger is a passionate advocate of the notion that science is an arm of national diplomacy efforts — an idea that is being challenged in Australia and beyond.

“The network is important so trust is built and we don’t think of people as other; they are like us and we can work together and form friendships. That’s why I think science has a strong diplomatic mission as well as a scientific mission,” Praeger says. “Science diplomacy can and must continue to work no matter what is happening in other areas.”

JULIE HARE

Field Mathematical Optimisation
Field leader Li Guoyin, UNSW
Leading institution UTS

Field Mathematical Physics
Field leader Peter Forrester, Uni of Melb
Leading institution Uni of Sydney

Field Nonlinear Science
Field leader Tonghua Zhang, Swinburne
Leading institution Swinburne

Field Optics & Photonics
Field leader Martin Green, UNSW
Leading institution ANU

Field Physics & Mathematics (general)
Field leader Daniel Brown, Uni of Adelaide
Leading institution ANU

Field Plasma & Fusion
Field leader Damien Hicks, Swinburne
Leading institution ANU

Field Probability & Statistics with Applications
Field leader Geoff McLachlan, Uni of Qld
Leading institution Monash

Field Pure & Applied Mathematics
Field leader David Wood, Monash
Leading institution Monash

Field Spectroscopy & Molecular Physics
Field leader Peter Gill, ANU
Leading institution Uni of QLD

Field Thermal Sciences
Field leader Kamel Hooman, Uni of Qld
Leading institution Uni of Adelaide

Health & Medical Sciences

Australia's research field leaders

This is an area of real strength for Australian universities where many institutions, including some outside of the research-intensive ones, do well. Universities such as Charles Sturt (in audiology, speech and language pathology), La Trobe (in developmental disabilities), Griffith (in nursing, in pregnancy and childbirth, and in natural medicine and medicinal plants) are field leaders. Not surprisingly specialist medical research institutions and hospitals also feature in the list. Non-university field leaders include Austin Health, the Murdoch Children's Research Institute and the SA Research and Development Institute. Some of the research stars who lead fields in the health and medical sciences discipline also have non-university affiliations including the Garvan Institute for Medical Research, Austin Health, QIMR Berghofer Medical Research Institute, the George Institute for Global Health, and the Florey Institute of Neuroscience and Mental Health. That said, the Group of Eight universities which have tremendous strength in health and medical research remain dominant in this discipline. They have well-established medical schools, most of them with deep links to large teaching and research hospitals as well as a strong network of medical research institutes. They are research powerhouses.

Field Addiction
Field leader Wayne Hall, Uni of Qld
Lead institution UNSW

Field AIDS & HIV
Field leader Garrett Prestage, UNSW
Lead institution UNSW

Field Alternative & Traditional Medicine
Field leader Caroline Smith, WSU
Lead institution UTS

Field Anesthesiology
Field leader Paul Myles, Monash
Lead institution Monash

Field Audiology, Speech & Language Pathology
Field leader Sharynne McLeod, CSU
Lead institution CSU

Field Bioethics
Field leader Wendy Rogers, Macquarie
Lead institution Uni of Sydney

Field Cardiology
Field leader Andrew Stewart Coats, Monash
Lead institution Uni of Adelaide

Field Child & Adolescent Psychology
Field leader Liz Pellicano, Macquarie
Lead institution La Trobe

Field Clinical Laboratory Science
Field leader Emmanuel Favaloro, NSW Govt
Lead institution SARDI

Field Communicable Diseases
Field leader Jason Roberts, Uni of Qld
Lead institution Uni of Melb

Field Critical Care
Field leader Jason Roberts, Uni of Qld
Lead institution Monash

Field Dentistry
Field leader Bartold Mark, Uni of Adelaide
Lead institution Uni of Adelaide

Field Dermatology
Field leader Dedee Murrell, UNSW
Lead institution Uni of Qld

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

Field Diabetes
Field leader Paul Zimmet, Monash
Lead institution Monash

Field Emergency Medicine
Field leader Peter Cameron, Monash
Lead institution Monash

Field Endocrinology
Field leader John Eisman, Garvan
Lead institution Monash

Field Epidemiology
Field leader Paul Glasziou, Bond
Lead institution Monash

Field Gastroenterology & Hepatology
Field leader Jason Grebely, UNSW
Lead institution Uni of Qld

Field Genetics & Genomics
Field leader Grant Montgomery, Uni of Qld
Lead institution University of Qld

Cheryl Dissanayake

Developmental psychologist

La Trobe University

Research leader in the field of developmental disabilities

During the third year of her science degree at Monash University, Cheryl Dissanayake attended a lecture by an inspiring behavioural geneticist, Stella Crossley, about autism. At that moment, her passion was "switched on".

However the developmental psychologist and founding director of La Trobe University's Olga Tennison Autism Research Centre traces her earliest interest to a documentary she saw on television as a schoolgirl.

"I watched a movie called *Son-Rise* about this couple who had an autistic boy and had developed a therapy around him," Dissanayake says. "I was fascinated by it."

During her long career, the definition of autism has broadened and its prevalence has risen. "In my PhD I cited that three to four in every 10,000 live births would be autistic," she says. "Now we say 1 per cent to 2 per cent, and in our work at the centre we're finding it's just over 2 per cent."

One ground-breaking paper came from her postdoctoral work at the University of California at Los Angeles working with Marion Sigman, an eminent researcher, on "the first really good longitudinal study. We were able to look at what predicts better long-term outcomes

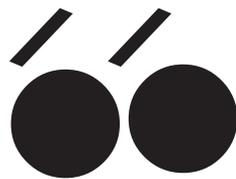
AARON FRANCIS



and this set the stage for much intervention research.”

Other crucial work has included studying very early signs — exhibited in social attention and communication behaviour — and training others to recognise them. Work that began 13 years ago with then PhD student Josephine Barbaro is coming to fruition. Barbaro — “leading the world in this” — has trained all the maternal and child health nurses in Tasmania, and the centre has the contract to do with same with all Victorian nurses and student trainees.

Other work has included debunking the idea that autistic children do not emotionally attach to their parents; establishing that



I still give lectures because I know that’s how people are ‘turned on’ to autism

diagnosis by 24 months followed by early intervention can yield “amazing results”; and lately, working on the best ways to minimise the 42 per cent unemployment rate among people with autism.

Dissanayake has never forgotten the seminal influence of a good teacher. “I still give lectures because I know that’s how people are ‘turned on’ to autism,” she says.

“We need much greater capacity to support the increasing numbers, so we need people in every profession knowing about autism and being able to support autistic people wherever they find themselves.”

JILL ROWBOTHAM

Field Gerontology & Geriatric Medicine
Field leader Perminder Sachdev, UNSW
Lead institution UNSW

Field Gynecology & Obstetrics
Field leader Ben Mol, Monash
Lead institution Uni of Qld

Field Health & Medical Sciences (general)
Field leader Alan Lopez, Uni of Melb
Lead institution Uni of Adelaide

Field Heart & Thoracic Surgery
Field leader Paul Bannon, NSW Govt
Lead institution Alfred

Field Hematology
Field leader Emmanuel Favaloro, NSW Govt
Lead institution Monash

Field Hospice & Palliative Care
Field leader David Currow, UTS
Lead institution UTS

Field Immunology
Field leader Mark Smyth, QIMR Berghofer
Lead institution Monash

Field Natural Medicines & Medicinal Plants
Field leader David Craik, Uni of Qld
Lead institution Griffith

Field Neurology
Field leader Christopher Rowe, Austin
Lead institution Uni of Sydney

Field Neurosurgery
Field leader James Smith, CDU
Lead institution UNSW

Field Nuclear Medicine, Radiotherapy & Molecular Imaging
Field leader Paul Keall, Uni of Sydney
Lead institution Uni of Sydney

Field Nursing
Field leader Tracy Levett-Jones, Uni of Newcastle
Lead institution Griffith

Field Nutrition Science
Field leader Clare Collins, Uni of Newcastle
Lead institution Uni of Qld

Field Obesity
Field leader Bruce Neal, George Inst
Lead institution Uni of Sydney

Field Oncology
Field leader Georgina Long, Uni of Sydney
Lead institution Uni of Sydney

Field Ophthalmology & Optometry
Field leader Robyn Guymer, Uni of Melb
Lead institution Uni of Melb

Field Oral & Maxillofacial Surgery
Field leader Camile Farah, UWA*
Lead institution Uni of Qld

Field Orthopedic Medicine & Surgery
Field leader Kate Webster, La Trobe
Lead institution Monash

Field Otolaryngology
Field leader Richard Harvey, Macquarie
Lead institution Macquarie

Field Pain & Pain Management
Field leader Lorimer Moseley, UniSA
Lead institution Uni of Sydney

Field Pathology
Field leader Anthony Gill, Uni of Sydney
Lead institution Uni of Sydney

Field Pediatric Medicine
Field leader Peter Anderson, Monash
Lead institution MCRI

Field Pharmacology & Pharmacy
Field leader Ian Mcgrath, Uni of Sydney
Lead institution Monash

* recently left institution

Health & Medical Sciences

Australia's research field leaders



Richard Harvey

Rhinologist, Macquarie University

Research leader in the field of otolaryngology

Richard Harvey is an academic surgeon, combining research with the practice of surgery. More specifically he is a rhinologist, treating nasal polyps, chronic sinusitis, skull base tumours and other conditions that involve allergy, infection and inflammation of the nasal cavity.

Having trained as an ear, nose and throat surgeon, Harvey made his decision to specialise in the nasal part of the trinity early on, based on the insight that one of the most common upper airway conditions — sinusitis — was widespread but misunderstood and, subsequently, mistreated.

“The belief was that the sinus was blocked and there was infection. It was treated with antibiotics. But that’s like treating asthma or dermatitis with antibiotics. The insight was that it was in fact inflammatory and that, in turn, has revolutionised the way we treat it,” Harvey says.

Unlike its closely related cousin asthma, sinusitis is not a national health priority, even while affecting 8 per cent of the population.

And it comes with a heavy cost.
“People have to take time off work

— presenteeism is common, as is absenteeism. Sufferers chew through a lot of medication trying to treat it and it impacts on the quality of life,” Harvey says.

To make matters worse, sinusitis affects people in the productive part of their lives — between 20 and 60.

Harvey’s academic affiliations are with Macquarie University and the University of NSW. His research team is based at Sydney’s St Vincent’s Hospital.

The St Vincents research group’s efforts have “changed the medical profession’s philosophy of treatment for chronic sinusitis”, Harvey says, noting that a randomised controlled trial last year was one of the most highly cited articles in rhinology in 2018.

He and his team have pioneered endoscopic skull base surgery in Australia for pituitary, sinus and skull base tumours and cancer. It involves a tiny camera that enters the body via the nose.

“We are driven by our passion that as surgeons and clinicians we don’t have all the answers for our patients and we can always do things better,” he says.

JULIE HARE

Field Physical Education & Sports Medicine
Field leader Aaron Coutts, UTS
Lead institution ACU

Field Physiology
Field leader John Hawley, ACU
Lead institution Monash

Field Plastic & Reconstructive Surgery
Field leader Karen Vickery, Macquarie
Lead institution Macquarie

Field Pregnancy & Childbirth
Field leader Jennifer Fenwick, Griffith
Lead institution Griffith

Field Health Care
Field leader Mark Harris, UNSW
Lead institution Uni of Sydney

Field Psychiatry
Field leader Ian Hickie, Uni of Sydney
Lead institution UNSW

Field Psychology
Field leader Roy Baumeister, Uni of Qld
Lead institution Uni of Melb

Field Pulmonology
Field leader Peter Gibson, Uni of Newcastle
Lead institution SARDI

Field Radiology & Medical Imaging
Field leader Kazuaki Negishi, Uni of Tasmania
Lead institution Uni of Sydney

Field Rehabilitation Therapy
Field leader Julie Bernhardt, Florey Inst
Lead institution Uni of Sydney

Field Reproductive Health
Field leader Robert Aitken, Uni of Newcastle
Lead institution Monash

Field Rheumatology
Field leader David Hunter, Uni of Sydney
Lead institution Uni of Sydney

Field Social Psychology
Field leader Roy Baumeister, Uni of Qld
Lead institution Uni of Melb

Field Surgery
Field leader Carlo Pulitano, NSW Govt
Lead institution Uni of Sydney

Field Toxicology
Field leader Neil Cameron, Monash
Lead institution Uni of Qld

Field Transplantation
Field leader Jeremy Chapman, NSW Govt
Lead institution NSW Govt

Field Tropical Medicine & Parasitology
Field leader Una Ryan, Murdoch
Lead institution Murdoch

Field Urology & Nephrology
Field leader Jonathan Craig, Flinders
Lead institution Monash

Field Vascular Medicine
Field leader Lawrence Beilin, UWA
Lead institution Monash

Field Veterinary Medicine
Field leader Paul McGreevy, Uni of Sydney
Lead institution Uni of Sydney

Bayden Wood

Monash University

Top interdisciplinary researcher

Bayden Wood is Australia's top interdisciplinary researcher. From his home discipline, spectroscopy and molecular physics, he branches into life sciences, engineering, chemistry and health. This staggering diversity is driven by his desire to apply his core skill of infrared spectroscopy across many scientific fields where it is applicable.

His work involves shining infrared light through biological substances to measure which wavelengths are absorbed. Different molecules have different signatures, so it can be a quick test to reveal what is present in a particular sample.

Professor Wood, who is co-director (with colleague Phil Heraud) of Monash University's Centre of Biospectroscopy, started down this track in his honours year when he began using infrared spectroscopy to investigate cervical cancer. There were many different types of cells involved in the samples he was studying. From there he moved into other fields of study, looking at algae cells, then leaves, which led to

phytology, the study of plants. "I started to build a large data base of different cell types from animals and plants. The whole thing built up from there," Professor Wood says.

His work also led him to research in other fields. As he delved into the theory of spectroscopy he started publishing optics papers. The complexity of interpreting the data he was capturing took him into the field of artificial intelligence.

Now he is applying the technology to testing body fluids to make more rapid diagnoses of diseases such as malaria, HIV and hepatitis. A key breakthrough was the discovery of the distinct infrared signatures of the malaria parasite. So sensitive are the testing methods he and his colleagues have developed that one infected malaria cell can be detected among 100,000 red blood cells using portable equipment.

He calls the technology a game-changer. "It's highly portable and robust for deployment in rugged isolated tropical environments," he says.

Now he is translating the technology to the real world, working through a company called Total Blood Profile on quick, cheap, accurate tests for pathogens.

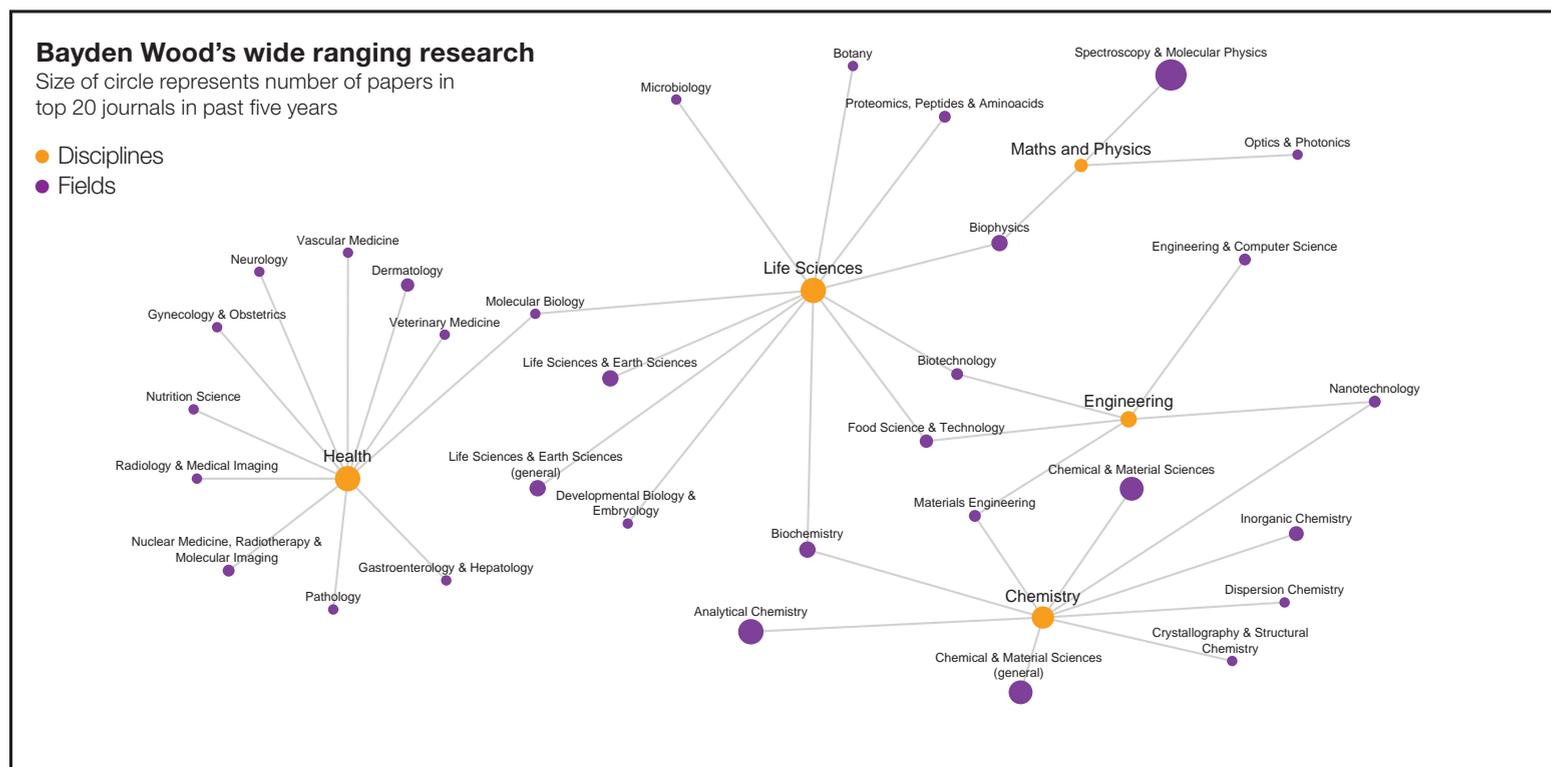


DAVID GERAGHTY

He says he has many great collaborators. "That's the secret to success, having a lot of really good scientists who are also prepared to come on board and use different types of technology."

He also credits his housemates, Dr Heraud and retired scientist Tony Eden. "We're always talking science and we do science together."

JILL ROWBOTHAM





At Australian Catholic University (ACU) research excellence means achieving outcomes above and well above world standard in areas that align with our mission as a Catholic university.

Over the past six years ACU's research intensification strategy has sought to achieve these outcomes by establishing research institutes that drive our research performance in our key priorities of education, health, and theology and philosophy.

The recent 2018 Excellence in Research for Australia (ERA) results demonstrate that we have achieved excellence in our strategic priority areas. They also show that ACU has become, within a relatively short period of time, a leading Australian university in research that reflects our core mission and identity.

Our research in health received 10 top scores of five, well above world standard, in medical and health sciences, and in psychology and cognitive sciences. For health sciences in the 2015 ERA we achieved five scores of five, one of four, and one of one. For health sciences in the latest ERA, there was not a single score below five and we doubled the number of scores of five that we achieved.

ACU has also made excellent progress with our scores in education. Our top score in specialist studies in education was the first time ACU has been recognised at well above world standard for

ACU consistently above world standard

education. Compared nationally, ACU was among only four universities that scored a five in the four-digit fields of research in education.

In religion and religious studies, ACU scored the highest result for any Australian university, achieving the only score of four awarded this year. No Australian university has ever scored a five in this field of research, and ACU is the only one to perform consistently above world standard over the past six years. With the recent expansion in biblical and early Christian studies, and medieval and early modern studies, ACU is well placed in pursuit of a five in the next ERA.

In philosophy, ACU has been recognised as above world standard for the past two ERA rounds. As one of our priority areas, ACU is committed to

the significant growth of research in philosophy to make it one of our major areas of research strength. ACU's bold vision is to become one of the world's leading centres in contemporary philosophical research.

To that end, ACU has established the Dianioia Institute of Philosophy. The appointment of Professor Stephen Finlay as institute director, a number of high-profile appointments already made, and extensive recruitment currently underway, will build international expertise in epistemology, ethics, metaphysics, social and political philosophy, philosophy of mind, language, and science, logic, aesthetics, history of philosophy, and philosophy of religion, thereby establishing a renowned philosophy program in the analytic tradition.

Our Rome campus continues to strengthen our global research partnerships. Recently ACU hosted a symposium of the International Centre for Self-Care Research with scholars from ACU and Boston College, both founding members of the Strategic Alliance of Catholic Research Universities.

The Institute of Religion and Critical Inquiry has held its annual Rome campus seminar series since 2015. This year's seminars on atheism, ethics, autonomy and early Christian modes of knowing, each held over several days, have gathered together scholars from the world's leading Catholic universities including Boston College, Katholieke Universiteit Leuven and Notre Dame, as well as top-ranked Cambridge, Columbia, Oxford and Yale. Multi-volume publications from these seminars are planned with Cambridge and Oxford university presses.

Research excellence at ACU has been further recognised by the Australian Research Council for its significant impact in advancing education, health and social outcomes. Research in early childhood learning and nursing was among the high-scoring case studies in this year's inaugural Engagement and Impact assessment. Find and Connect — historical research that enables care leavers and counselling services to access national records for children identified in the Forgotten Australians report — was also recognised for its high impact.

The university's investment in education, health, and theology and philosophy ensures that our research excellence strategy aligns with our institutional focus as we prepare for our next stage of growth as a world-leading Catholic university.

Professor C.W.F. McKenna
DEPUTY VICE-CHANCELLOR (RESEARCH)
AUSTRALIAN CATHOLIC UNIVERSITY



Diffuse Energy benefits from I2N support

Newcastle nurtures an innovation ecosystem

It's now widely acknowledged that networks of innovation and entrepreneurship are major pillars for economic growth and job creation. But at the University of Newcastle, we're taking this a step further. Our Integrated Innovation Network (I2N) links the university with partner incubation and acceleration hubs to help nurture ideas and support start-ups.

It brings together researchers, businesses, community organisations and government partners to develop new opportunities and new industries.

Unlike many other enterprise development programs delivered by tertiary education institutions, I2N deploys a bottom-up approach which is inclusive of everyone, regardless of university affiliation.

That might mean supporting student, researcher, alumni or community-initiated enterprise from having a great idea, to developing sustainable pathways to global markets. Our aim is to build stronger entrepreneurs who can help deliver jobs and economic diversity. It's a community approach, with the university acting as the city-region's entrepreneurial engine.

At the heart of I2N are three strategically positioned hubs. These facilities are home to entrepreneurs building their networks and sharing their wins and failures via a series of open-access connection events, while also developing their skill-base through specially designed programs delivered in a supportive and inclusive environment—all the

right ingredients for the making of a vibrant innovation ecosystem.

And it's led to some great success stories.

Successes like Diffuse Energy, which has seen Newcastle engineers Joss Kesby, James Bradley and Sam Evans discover a way to double the energy production of standard wind turbines. The innovative technology lies in the design of a diffuser, an aerodynamic ring that surrounds the turbine, making it twice as efficient, quieter and safer. The technology is being applied in off-grid telecommunications, mining and agriculture, as well as by owners of caravans, yachts and tiny homes looking for sustainable energy options.

Then there are stories like Yolanda Surjan's Creatures & Co, which uses proven radiation therapy for humans and applies it to skin cancers for animals. A former student and now researcher and lecturer at the University of Newcastle, Yolanda and her team now successfully provides radiation therapy to horses, cats and dogs in Sydney. By providing better, safer and kinder cancer therapy for pets, it is hoped that radiation therapy services will become a common feature in veterinary clinics, not just in hospitals and health service departments.

And then there's MGA Thermal. The team, made up of university researchers Professor Erich Kisi, Dr Alex Post and Dr Dylan Cuskelly, has uncovered a way to blend metals such as zinc and non-metals such as carbon into a modular form capable of storing energy when heated. The result

is a world-first thermal storage material, Miscibility Gap Alloys (hence the MGA) that is capable of revolutionising energy storage systems by providing a cleaner, more economic and scalable method. It is this capability that has seen the company make front-page headlines locally.

There are many more inspiring stories of researchers, with the support of I2N, seeing their ideas grow and become genuine solutions to real-world issues.

Indeed, since becoming the first regional node for delivery of the CSIRO's ON Prime program in 2017, the University of Newcastle boasts the largest number of researchers participating in the program out of any university in Australia and has seen I2N support the development of four spin-off companies.

This speaks volumes about Newcastle's appetite for an entrepreneurial community.

Besides obviously great ideas and research, what's helped these enterprises succeed is the network of innovation hubs we've created through I2N.

This infrastructure supports knowledge and skills exchange and is acting as a catalyst for change on the socio-economic development of the region. I2N is helping connect and integrate education and research with entrepreneurs, policy institutions, existing SMEs and prospective funders.

By bringing together diverse groups of stakeholders who can experiment with ideas, concepts, technologies, teaching and learning approaches and commercial innovations, we're supporting entrepreneurial activity across a breadth of sectors.

This culture is also self-perpetuating. There's great evidence that suggests developing a successful innovation ecosystem leads to a strong culture of "entrepreneurial recycling", whereby entrepreneurs who build successful companies that they go on to sell, typically reinvest their wealth and experience as mentors to generate and support further entrepreneurial activity within the community.

It's this culture of sharing knowledge and expertise that we're seeing develop in our region.

Through the I2N, we're creating a knowledge economy that is delivering high-value jobs and a diversified economy, as well as real-world solutions to some of the world's greatest challenges.

Visit newcastle.edu.au/i2n

Professor Deborah Hodgson

ACTING DEPUTY VICE-CHANCELLOR
(RESEARCH & INNOVATION)

Siobhan Curran

SENIOR MANAGER, INTEGRATED INNOVATION
NETWORK (I2N)

UNIVERSITY OF NEWCASTLE

Humanities, Arts & Literature

Australia's research field leaders

Our methodology gives the humanities, arts and literature discipline far more space than they receive in most traditional university ranking systems, which lean towards science and technology. This flows from our decision to use Google Scholar's taxonomy in constructing our tables. We list

leading researchers and research institutions in fields as various as ethnic and cultural studies (Deakin University), Middle Eastern and Islamic studies (Griffith University), visual arts (Charles Darwin University), Chinese studies and history (UNSW), literature and writing (Australian National University), philosophy (Macquarie University), American literature and studies (Swinburne University), foreign language learning (Macquarie University), and history (Monash University).

Field African Studies & History
Field leader Alison Crowther, Uni of Qld
Lead institution CSU

Field American Literature & Studies
Field leader Trevor Burnard, Uni of Melb
Lead institution Swinburne

Field Asian Studies & History
Field leader Edward Aspinall, ANU
Lead institution ANU

Field Chinese Studies & History
Field leader Yanrui Wu, UWA
Lead institution UNSW

Field Communication
Field leader David Rowe, WSU
Lead institution QUT

Field Drama & Theater Arts
Field leader Erin Brannigan, UNSW
Lead institution UniSA

Field English Language & Literature
Field leader Ahmar Mahboob, Uni of Sydney
Lead institution Curtin

Field Epistemology & Scientific History
Field leader Jakob Hohwy, Monash
Lead institution ANU

Field Ethnic & Cultural Studies
Field leader Amanda Wise, Macquarie
Lead institution Deakin

Field Feminism & Women's Studies
Field leader Ngaire Donaghue, Uni of Tasmania
Lead institution Deakin

Field Film
Field leader Sean Maher, QUT
Lead institution Curtin



Felicity Baker

Musicologist, University of Melbourne

Research leader in the field of music and musicology

Felicity Baker has seen music carve through the thick fog of an elderly person's dementia and bring them back to reality, to a world where they can again recognise their children and, in the best cases, even communicate with them.

"Through music activating them, they become more aware of their surroundings and they sometimes start recognising people again," Baker says. "It might only be momentarily, but momentarily is better than nothing".

Using music to lessen the daily despair of dementia has been the major theme of her research. She is now studying exactly how powerful music therapy can be for people with dementia, whether the effects last, and whether group sing-alongs can work just as well as one-on-one music therapy.

STUART MCEVOY

Continued next page

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

Field French Studies
Field leader Christopher Watkin, Monash
Lead institution Uni of Canberra

Field Gender Studies
Field leader Marika Tiggemann, Flinders
Lead institution Uni of Sydney

Field History
Field leader Lyndon Moore, Uni of Melb
Lead institution Monash

Field Humanities, Literature & Arts (general)
Field leader Loretta Baldassar, UWA
Lead institution Deakin

Field Language & Linguistics
Field leader Evan Kidd, ANU
Lead institution ANU

Field Latin American Studies
Field leader Sean Burges, ANU
Lead institution Uni of Sydney

Field Literature & Writing
Field leader Stephen Muecke, UNSW
Lead institution ANU

Field Middle Eastern & Islamic Studies
Field leader Shahram Akbarzadeh, Deakin
Lead institution Griffith

Field Music & Musicology
Field leader Felicity Baker, Uni of Melb
Lead institution Deakin

Field Philosophy
Field leader Neil Levy, Macquarie
Lead institution ANU

Field Religion
Field leader Lindsay Carey, La Trobe
Lead institution Uni of Melb

Field Sex & Sexuality
Field leader Andrew Grulich, UNSW
Lead institution UNSW

Field Visual Arts
Field leader Jon McCormack, Monash
Lead institution CDU



Marika Tiggemann Psychologist Flinders University Research leader in gender studies

Marika Tiggemann has found the West's ever-increasing obsession with body image, fat shaming and the insecurities of the Instagram generation a rich field for her research.

"Some of the things we're looking at are things like the Body Positive movement, and

trying to use social media positively," says the distinguished psychology scholar. "There are experiments showing people real images. There's a movement, Instagram versus Reality. We have a study in progress looking at that."

Research has found that even labelling doctored images as Photoshopped, she says, fails to significantly blunt their power. People read the words and understand, intellectually, that the photos don't depict reality, yet still compare themselves to the false images.

Tiggemann's work on the subject began with her research into "learned helplessness", as mooted by American psychologist Martin Seligman, who found that after repeated failures, people stop trying to escape stressful situations. This can apply to people's feelings about their bodies.

Social media, she says, often has a demoralising effect, particularly young people. They compare themselves with the purportedly real-life body-beautiful images regularly seen on Instagram and Facebook and feel inferior.

Women's growing independence has done little to stem the tide of insecurity, she says. "There was a time when people thought body image, particularly as an issue for women, might go away as women gained more equality in the workplace and became financially independent, but that didn't seem to happen," she adds.

Tiggemann has also investigated the widespread desire for cosmetic surgery, and whether seeing a selection of photos of other people's shapes and sizes leads to the realisation that surgery was not required to fit into the range of normal bodies.

SIAN POWELL

Continued from previous page

Jogged back into reality with the power of music, dementia patients appear happier and easier to care for, she has found. Music can even diminish their reliance on drugs.

Baker is leading a \$3.9 million global research trial in Australia, Poland, Germany, Norway and the UK investigating how home-carers can use music to soothe their distressed or aggressive dementia patients, either by singing to them or playing them recorded music.

The next phase of the research will be to develop an app to help home-carers use music in the daily care of their relatives with dementia.

A music therapy specialist who earned her doctorate at Aalborg University in Denmark, then the leading institution in the field, Baker worked as a music therapy clinician in dementia care and neuro-rehabilitation before returning to academia.

"Music therapy works not only with people who were musicians, or once had a particularly wide understanding of music," she says. "There are plenty of people out there who respond in a very strong way because music affects them emotionally or it's strongly connected with their memories."

Music therapists work with a concept called the "reminiscence bump", which is a period in the patient's life, usually between their late teens and early 30s, when identity is formed, love is found and enduring memories, often associated with music, are laid down.

"So when we work with people with dementia, we always go to that era of music first, whatever music was current in their life at that time", Baker says. "It helps to connect them and take them back to those earlier times. They really come to life."

"You can actually see them processing and remembering those times."

SIAN POWELL

Collaboration is in the DNA of Macquarie University. Through it, we are helping children to discover the joy of reading; seeking cures for diseases such as motor neurone disease and melanoma; developing heat-resistant crops for a climate-changed world; and exploring ways the aged care sector can better care for the elderly.

The list goes on.

Macquarie was created 55 years ago in the northern suburbs of Sydney to be collaborative and entrepreneurial, and to engage closely with end users to ensure its research translated into real-world impacts.

Today, those impacts happen all around us, every day. The university sits at the heart of the Macquarie Park Innovation District (MPID), a precinct that is revolutionising the way in which big ideas come to life.

The MPID is home to the Macquarie University Hospital, the Macquarie University Incubator, the Australian Hearing Hub, more than 180 large international companies and 200 small and medium businesses.

Among those is MultiLit, where evidence-based, cost-effective literacy intervention programs help hundreds of children with reading difficulties using a methodology developed at Macquarie, and continually informed by ongoing research.

Seattle-based VoiceBox Technologies in partnership with the university opened an office in the MPID in 2016 to commercialise Macquarie research that is combining linguistics and computing to create novel voice-recognition technologies.

Start-up Modular Photonics is taking to market the plug-and-play OMPlex passive silica chip, a Macquarie invention which cheaply and quickly retrofits legacy fibre-optic networks to speed up data flow without the need to recable.

They are only three among many examples, all reflecting a culture of collaboration that extends globally but starts in our own backyard.

Structures such as faculties and departments are there to organise the university but not to organise our research, which takes place across disciplinary boundaries. Whether you are in social sciences or engineering or medicine, it doesn't matter — we look at a problem and we try and solve it. We hunt in packs.

In 2013 and 2014, the university went through a 15-month consultation across the faculties to identify what we as a university wanted to achieve with our research.

Out of that process came five future-shaping



Macquarie makes a real-world impact

research priorities: Healthy People, Resilient Societies, Prosperous Economies, Secure Planet and Innovative Technologies.

We also established four broad objectives for academic achievement. The first of those is to accelerate research performance, which involves all our staff members aspiring to excellence. The second is to prepare world-ready higher degree research (HDR) candidates. Honours degrees are no longer the main pathway into our PhD program; instead we have a two-year Master of Research because we believe it is a better pathway into a PhD at Macquarie or beyond.

This structure follows the Bologna model, which brings us into line with many northern hemisphere universities and therefore opens the way for co-supervision of HDR candidates and research partnerships. For instance, our partnership with the University of Hamburg lets students do half their PhD in Germany and half at Macquarie, working on collaborative projects.

Another of our objectives is to have a world-changing impact, and we define that not only in terms of high-impact journal articles or books but impact on policy and technology, in ways that improve quality of life and make the planet more sustainable.

And we aim to be a world-recognised collaborator of choice, and not only with international universities but with local universities, research agencies such as the CSIRO, and end-user stakeholders including industry. If people partner with us, they should know that they can trust us; that we will deliver our part of the bargain no matter what.

Within MPID, we seek to match our capabilities and areas of expertise with the needs of end users such as Australian Astronomical Optics, Cochlear and Optus.

But we reach out nationally and globally too. Figures in the university's latest annual report show that 102 countries enjoyed research collaborations with Macquarie.

The Yeast 2.0 project is an example of a truly international, world-changing collaboration that could ultimately reduce humanity's reliance on fossil fuels. Since 2014, teams of scientists across five countries have been working to create the world's first synthetic complex organism: a designer, living version of baker's yeast. In Australia, Macquarie has been the project's lead institution, working with teams in Britain, China, Singapore and the United States.

This partnership has grown tighter over the years — akin to the concept of "amicitia", a word borrowed from ancient Rome. In the spirit of amicitia, collaborative action is performed in an environment of mutual respect balanced with self-interest: one commits to collaborate and to contribute but one is never expected to experience harm or to neglect one's own self-interest.

Back at the Macquarie University campus, in such a friendly and collaborative place, you have to be careful not to become cosy. There should always be a hunger and an aspiration to do more and do better, to push the boundaries and look for new frontiers, and that is what collaboration offers to a university such as Macquarie that embraces those ideals.

Professor Sakkie Pretorius
DEPUTY VICE-CHANCELLOR (RESEARCH)
MACQUARIE UNIVERSITY

Life Sciences & Earth Sciences

Australia's research field leaders

Field Agronomy & Crop Science
Field leader Bhagirath Chauhan, Uni of Qld
Lead institution CSIRO

Field Animal Behaviour & Ethology
Field leader Bob Wong, Monash
Lead institution Macquarie

Field Animal Husbandry
Field leader Jennie Pryce, La Trobe
Lead institution UNE

Field Atmospheric Sciences
Field leader Julie Arblaster, Monash
Lead institution CSIRO

Field Biodiversity & Conservation Biology
Field leader Jane Elith, Uni of Melb
Lead institution Uni of Melb

Field Birds
Field leader Phillip Cassey, Uni of Adelaide
Lead institution ANU

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

Field Cell Biology
Field leader Andreas Strasser, WEHI
Lead institution Monash

Field Developmental Biology & Embryology
Field leader Ed Stanley, MCRI
Lead institution Monash

Field Ecology
Field leader Jane Elith, Uni of Melb
Lead institution Uni of Melb

Field Environmental & Geological Engineering
Field leader Scott Sloan, Uni of Newcastle
Lead institution Curtin

Field Environmental Sciences
Field leader Huu Hao Ngo, UTS
Lead institution UTS

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

Field Food Science & Technology
Field leader Benu Adhikari, RMIT
Lead institution Uni of Qld

Field Forests & Forestry
Field leader David Forrester, Uni of Melb
Lead institution Uni of Melb

Field Geochemistry & Mineralogy
Field leader William Griffin, Macquarie
Lead institution Curtin

Field Geology
Field leader Peter Cawood, Monash
Lead institution Curtin

Field Hydrology & Water Resources
Field leader Adrian Werner, Flinders
Lead institution CSIRO

Field Insects & Arthropods
Field leader Michael Furlong, Uni of Qld
Lead institution CSIRO

Field Life Sciences & Earth Sciences (general)
Field leader Peter Visscher, Uni of Qld
Lead institution James Cook

Field Marine Sciences & Fisheries
Field leader Michael Borowitzka, Murdoch
Lead institution CSIRO

Field Microbiology
Field leader Staffan Kjelleberg, UNSW
Lead institution Uni of Qld

Field Molecular Biology
Field leader John Mattick, Garvan
Lead institution Monash

Field Mycology
Field leader Brett Summerell, NSW Govt
Lead institution CSIRO

Field Oceanography
Field leader Isaac Santos, SCU
Lead institution CSIRO

Field Paleontology
Field leader Guang R Shi, Deakin
Lead institution Deakin

Field Pest Control & Pesticides
Field leader Bhagirath Chauhan, Uni of Qld
Lead institution CSIRO

Field Plant Pathology
Field leader Bhagirath Chauhan, Uni of Qld
Lead institution Uni of Qld

Field Proteomics, Peptides & Aminoacids
Field leader Suresh Mathivanan, La Trobe
Lead institution Monash

Field Soil Sciences
Field leader Alex McBratney, Uni of Sydney
Lead institution Uni of Sydney

Field Sustainable Development
Field leader Bradley Ridoutt, CSIRO
Lead institution CSIRO

Field Sustainable Energy
Field leader T M Indra Mahlia, UTS
Lead institution UNSW

Field Virology
Field leader Edward Holmes, Uni of Sydney
Lead institution UNSW

Field Wood Science & Technology
Field leader Warren Batchelor, Monash
Lead institution Monash

Field Zoology
Field leader Adam Slipinski, CSIRO
Lead institution Deakin

N

ot at all surprisingly, the institution which dominates the list of leaders in life sciences and earth sciences is Australia's biggest public sector research body, the CSIRO.

It leads in agronomy and crop science (a tribute to its role in building Australia's agricultural industries), atmospheric sciences (where

it has always been strong), hydrology and water resources (reflecting its work in preserving the country from the impact of drought), insects and arthropods (probably due to its work on agricultural pests), marine science and fisheries (where it fills its role of supporting resource industries), mycology (the study of fungi, increasingly important to analysing the carbon cycle), oceanography (again a traditional area of expertise), pest control and pesticides (again supporting Australian industry), and sustainable development (a more recent field in which it shines).

Looking at other leading institutions is also instructive, with many coming from outside the group of research intensive universities. The University of New England is the leader in animal husbandry, James Cook University is the leader in life sciences and earth sciences (general), Charles Sturt University is a leader in studies of birds, and Deakin University is a leader in paleontology and zoology.

In global terms Australia is strong in many of the fields of this discipline. In the strictly research-based global ranking, the Academic Ranking of World Universities, Australian universities do very well in agricultural sciences, with six institutions in the top 50, led by the University of Western Australia. It is what we would expect given the priority to do research in agriculture, which directly benefits one of Australia's strongest industries.



A one degree rise in average temperatures doesn't sound like a lot, but it can have a really big impact



Julie Arblaster
Climate scientist, Monash University
Research leader in the field of atmospheric science

When she was a kid in the Mallee in Victoria, Julie Arblaster spent a lot of time outside, swimming in the Murray and roaming in the bush. Weather has always been an important part of her life, and these days it is central to her profession.

Now an associate professor at Monash University's School of Earth, Atmosphere and Environment, Arblaster works on huge models that run on super-computers to better understand the global climate, how it's changing now and how it might change in the future. The often-unpalatable conclusions go to policy-makers to help them plan for an uncertain future.

"We know that greenhouse gases like CO₂ trap heat and prevent it from escaping into space, we've known that for 150 years," Arblaster says. "But we need to know how much that increase in greenhouse gases will warm the system and how rapidly it will warm, the consequences that warming will have, how it will change our rainfall patterns, how it might change heatwaves, and whether we can we reverse that warming."

Understanding the extremes of climate change is crucial, she adds, because the resulting flash floods and crippling heatwaves affect people's health and

wellbeing. "A one degree rise in average temperatures doesn't sound like a lot, but it can have a really big impact on the extremes, like the heatwaves and the extreme rainfall events, that lead to the flooding we saw in Queensland a few years ago," she says.

Although climate change has become a largely accepted fact of life nearly everywhere, how best to deal with it is now a matter of global debate. Meanwhile Arblaster and her colleagues keep crunching the data from multiple sources to predict as accurately as possible what lies ahead.

"Because we're moving into a regime that we haven't seen for

millions of years, in terms of the amount of CO₂ in the atmosphere, the climate models are the best tools we have to understand the future changes," she says.

Over time, the models have proved remarkably accurate. "They're not perfect obviously, but the ones we were running 20 years ago gave projections for now that are pretty close to what's happened," she says. "If we want to stay below 1.5 or 2 degrees warming above the pre-industrial level, which is what all the countries signed up to in Paris, then we need to start reducing emissions as soon as possible."

SIAN POWELL

Life Sciences & Earth Sciences
Australia's research field leaders



The problem is, the environment is changing. When the niche is empty, the weeds, the pests, the organisms that are biologically very tolerant, they move in

scientifically described species of beetle in Australia, and a further 30,000 or 40,000 that have never been described.

Originally from Poland, Dr Slipinski immigrated to Australia to work with the Australian Insect Collection at CSIRO in 2000. Fed up with administrative work in Poland, he wanted to return to pure science, and he noted that compared with Europe, where most species have been carefully catalogued with keys to identify them, there wasn't much scientific literature of that type in his new home country. He decided a proper and comprehensive register of Australian beetles was required.

"We are now working on a series of four, maybe even five volumes of Australian beetles," he explains, adding that this major book series, also available in a digital version, will guide beetle identification at the genus level.

"In principle, what I'm working on is the evolution of beetles, how to classify them properly, how to recognise them and how utilise them for biological control, or environmental impact."

With his intense focus on the CSIRO beetle collection, Dr Slipinski has noticed that various species of Australian beetles seem to be shrinking in numbers. "Looking at the historical collections we have, and looking at what we're collecting these days, there is a big discrepancy," he says. "Something has changed."

Entomologists in the northern hemisphere have monitored the crash of various species, including honeybees, and Dr Slipinski believes something similar is happening in Australia, which could have devastating environmental consequences down the line.

"The environment is changing," he adds. "When the niche is empty, the weeds, the pests, the organisms which are biologically very tolerant, they move in."

SIAN POWELL

Adam Slipinski
Entomologist, CSIRO
Research leader in the field of zoology

Adam Slipinski is passionate about beetles. Now immersed in the massive task of identifying and classifying thousands of Australian species for the definitive CSIRO catalogue on these insects, he says a proper understanding of these creatures is crucial. Although they can be serious pests, he says, beetles also provide essential

environmental services — they are pollinators, scavengers of refuse and pest predators.

Beetles are major pollinators of avocado plants. Dung beetles, first imported to Australia by CSIRO in the 1960s, clean up horse and cattle excrement, keeping bush fly numbers down. Ladybirds, a widespread family of small beetles,

are one of the more important biological control agents, attacking scale insects and aphids. "We are starting to appreciate that," Dr Slipinski says. "People don't want to use chemicals any more."

In charge of CSIRO's beetle collections, which run to about 8 million specimens, Slipinski says there are about 30,000 already

UNSW raises the bar for engagement and impact

Australian universities are performing spectacularly well in global research rankings, with seven among the world's top 100.

This is impressive considering we have only 0.3 per cent of the world's population and face strong global competition, especially from China, the emerging research powerhouse.

UNSW itself is on a stellar trajectory. Our university is 43rd in the QS World University Rankings, has risen 25 places to 71st in the latest Times Higher Education World University Rankings and, over two years, has made the leap from 133rd to 94th in the Academic Ranking of World Universities.

In the most recent Australian government Excellence in Research for Australia assessment, UNSW was a leader in the combination of research quality and research impact [see graphic].

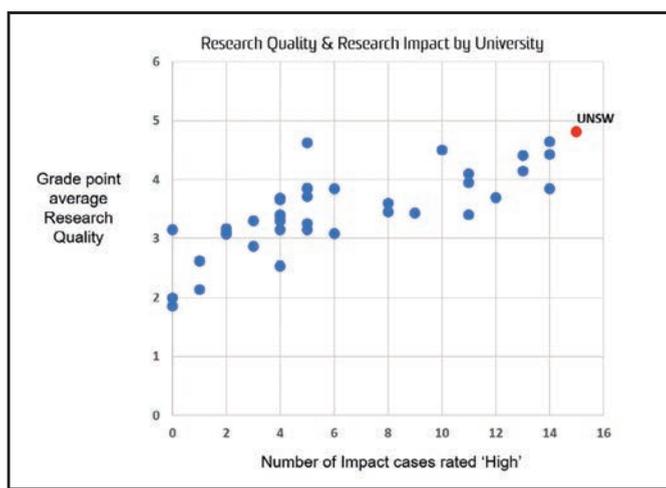
Our research quality and outcomes were found to be “above world standard” in most categories, while in the engagement and impact assessment, UNSW achieved the highest rating in more units of assessment than any other Australian university.

Evidence of the positive impact of research on society helps dispel the myth that researchers work in isolation from the real world.

That balance of the practical and the scholarly is enshrined in the UNSW motto: *Scientia Manu et Mente* — Knowledge by Hand and Mind.

Ensuring the knowledge we accumulate has application drove UNSW's pioneering research in solar energy cells 40 years ago, and is equally evident in our work today.

It is evident in our Centre for Sustainable Materials Research & Technology as it turns waste, otherwise destined for landfill, into green steel and products like benchtops and flooring. And it is evident in our new Fertility and Research Centre, which will offer fertility preservation for young people with cancer and rare genetic diseases.



The success of countless world-leading innovations originating from UNSW, and from Australia's university sector more broadly, is not just measured in the tenfold return on the public money invested, but in the lives they have changed and saved.

However, Australian universities are somewhat constrained by our capacity to translate what we do.

Too many projects reach dead ends and too many billions of dollars are lost overseas due to lack of investment in the translation, application and commercialisation phases of our research pipeline.

UNSW has been vocal in its belief that greater collaboration between universities and industry is the key to remedying this.

Universities have unparalleled research infrastructure and networks, and the best research talent. Industry's expertise lies in its understanding of societal needs, its real-time knowledge of what is commercially viable, and its capacity to mass produce, market and distribute.

The success of the high-tech sector, for example, will rely on the expertise in design, science and engineering found in our universities.

But the number of university-industry collaborations, as Education Minister Dan Tehan recently noted, is low compared to other OECD

countries. Compounding this is the fact that direct Commonwealth investment in R&D has fallen to a 40-year low of just 0.5 per cent of GDP, compared to other OECD countries such as the US, China and Israel, which invest 2.1-4.5 per cent of GDP.

The 2016 Review of the R&D Tax Incentive and the 2018 report Australia 2030: Prosperity Through Innovation recommended a collaboration premium to pull industry towards publicly funded research institutions.

The initiative could address a problem flagged by Scott Morrison when, as treasurer, he announced changes to the R&D Tax Incentive, citing a lack of industry research intensity. A collaboration premium would incentivise partnerships across a richer spectrum and could be budget-neutral.

Another idea we have proposed is an Australian Research Translation Fund as a non-health parallel to the Medical Research Future Fund. This concept became a recommendation in last year's Parliamentary Review on Government Funding Arrangements for non-NHMRC Research.

An ARTF would complement the research funded by the Australian Research Council, encouraging translation of the government's priority research areas such as soil and water, energy, environmental change and cyber security. These are areas which underpin the prosperity and functioning of our communities and cities.

The potential of a stronger collaboration framework for the two sectors is immense and one which Australian universities would welcome.

Professor Ian Jacobs
PRESIDENT AND VICE-CHANCELLOR

Professor Nicholas Fisk
DEPUTY VICE-CHANCELLOR, RESEARCH
UNIVERSITY OF NEW SOUTH WALES

Chemical & Material Sciences

Australia's research field leaders

This is the smallest discipline in Google Scholar's research taxonomy, but it is growing as areas which were previously placed elsewhere, such as nanotechnology and molecular modelling, have migrated back from the discipline of engineering and computer science.

There are many institutions that show depth in specialised fields in this discipline. In six fields the leading researcher comes from the university which leads in that field, demonstrating that the institutional expertise runs deep.

These are: Michael Breadmore (analytical chemistry) from the University of Tasmania; Shi Zhang Qiao (chemical and material sciences, general) from the University of Adelaide; Evatt Hawkes (combustion and propulsion) from UNSW; Stuart Batten (crystallography and structural chemistry) from Monash University; Hua Kun Liu (electrochemistry) from the University of Wollongong, and David Craik (medicinal chemistry) from the University of Queensland.

Field Analytical Chemistry
Field leader Michael Breadmore, Uni of Tasmania
Leading institution Uni of Tasmania

Field Biochemistry
Field leader John Mattick, Garvan
Leading institution Monash

Field Ceramic Engineering
Field leader Shujun Zhang, Uni of Wollongong
Leading institution UNSW

Field Chemical & Material Sciences (general)
Field leader Shi Zhang Qiao, Uni of Adelaide
Leading institution Uni of Adelaide

Field Chemical Kinetics & Catalysis
Field leader Shaobin Wang, Uni of Adelaide
Leading institution Monash

Field Combustion & Propulsion
Field leader Evatt Hawkes, UNSW
Leading institution UNSW

Field Composite Materials
Field leader Alan Kin Tak Lau, Swinburne
Leading institution RMIT

Field Crystallography & Structural Chemistry
Field leader Stuart Batten, Monash
Leading institution Monash

Field Dispersion Chemistry
Field leader Shaobin Wang, Uni of Adelaide
Leading institution Uni of Qld

Field Electrochemistry
Field leader Hua Kun Liu, Uni of Wollongong
Leading institution Uni of Wollongong

Field Inorganic Chemistry
Field leader Paul Low, UWA
Leading institution Uni of Qld

Field Materials Engineering
Field leader Shi Zhang Qiao, Uni of Adelaide
Leading institution Uni of Wollongong

Field Medicinal Chemistry
Field leader David Craik, Uni of Qld
Leading institution Uni of Qld

Field Molecular Modelling
Field leader Alessandro Soncini, Uni of Melb
Leading institution University of Melbourne

Field Nanotechnology
Field leader Shi Zhang Qiao, Uni of Adelaide
Leading institution Monash

Field Oil, Petroleum & Natural Gas
Field leader Alireza Bahadori, SCU
Leading institution Curtin

Field Organic Chemistry
Field leader Yusuke Yamauchi, Uni of Qld
Leading institution UNSW

Field Polymers & Plastics
Field leader Christopher Barner-Kowollik, QUT
Leading institution Monash

John Mattick

Molecular biologist Garvan Institute of Medical Research Research leader in the field of biochemistry

It was in 1978 while sitting in a pub in Texas that John Mattick had an epiphany. The molecular biologist and his friends were discussing the surprising finding that most of the human genome — the DNA in our cells — did not fit the conception of conventional genes (which specify proteins through an intermediate called RNA), and was therefore thought to be useless.

"I said to myself in that moment that there was a more plausible and far more interesting explanation — that this 'non-coding' RNA was communicating some other form of genetic information," says Mattick, a senior research fellow at Green Templeton College, Oxford.

It struck him that this "junk" DNA was making a lot of RNA that did not get translated into proteins.

Fast forward 16 years and Mattick wrote his first paper on the subject. He came to understand that unlike DNA, which bears the hereditary information that parents pass on to their children, RNA controls the way the genome is organised and expressed during development, especially from conception through childbirth, but throughout life.

Through this and other work — he kept publishing in the conventional scientific space to "make sure my track record

BRITTA CAMPION



remained respectable" — Mattick has been at the forefront of genomics in Australia and globally.

Before moving to the UK for a brief assignment as head of Genomics England, he was director of the Garvan Institute in Sydney and foundation director of the Institute of Molecular Bioscience in Brisbane.

In between he went back to the lab "to prove everyone wrong about the human genome".

He realised that advances in genomics were leading to a societal revolution in personalised medicine by moving the healthcare

system from a crisis response model to a wellness management model. "The ability to analyse personal genomic information will change the world," he says.

About one in 10 people will have a serious medical condition in their lifetime due to damage to a protein-coding gene. Mattick says: "Understanding the nature of the damage allows the risk of disease to be reduced or avoided and for treatments to be better targeted."

He will return to Australia next month to collect a 2019 Advance Australia Global Impact Award.

JULIE HARE



David Craik
Structural biologist
University of Queensland
Research leader in the field
of medicinal chemistry

When the ancient Greek physician Hippocrates uttered his famous line "Let food be thy medicine and medicine be thy food", he probably didn't have in mind what David Craik and his team at Brisbane's Institute for Molecular Bioscience at the University of Queensland have been up to.

Craik is a chemist and structural biologist. In recent years he's turned his mind to how to grow drugs in plants such as sunflower seeds, soy beans and peanuts which will, in turn, be consumed as food, potentially replacing expensive laboratory-made pharmaceuticals — a boon in developing nations.

This potential pharmaceutical revolution goes back to the 1990s when he made a remarkable discovery about the structure of proteins in a small number of plants.

"It had been observed that women in Africa would make a tea from a weedy plant when in labour which would accelerate labour and child birth," Craik says.

"The active ingredient was a peptide. I analysed it and found it had an unusual structure that explained why it could be boiled and orally ingested, because most peptides, such as insulin, get destroyed by the digestive enzymes and that's why they have to be injected."

The peptides, which have been found to occur in some species of five plant families, are circular — like a snake eating its tail. He called them cyclotides.

That discovery led to the development of honeybee-safe pest-control products, but now Craik has put his mind to re-engineering cyclotides that have the potential to revolutionise the pharmaceutical industry.

Craik says his revolutionary approach "will really change the paradigm for how we think about medicines in the future. They will be much safer and with fewer side effects, much more potent so we can use lower doses," he says.

DAVID SPROULE

JULIE HARE

Early Achievers Leaderboard

Rising stars

These are Australia's top 40 researchers who are less than 10 years into their careers. The best five performers have been selected from each of the eight main disciplines

Colour legend

- Business, Economics & Management
- Chemical & Material Sciences
- Engineering & Computer Science
- Health & Medical Sciences
- Humanities, Arts & Literature
- Life Sciences
- Physics & Mathematics
- Social Sciences



Alexander Newman
**Human Resources
and Organisations**

At Deakin University, his research interests are organisational behaviour, leadership and entrepreneurship



Muchazondida Mkono
Tourism and Hospitality

At the University of Queensland, her research interests include social movements, tourism and social media



Martin Obschonka
**Human Resources
and Organisations**

At QUT, he is a psychologist who researches vocational development and economic culture



Haywantee Ramkissoon
Tourism and Hospitality

At Monash University, she studies the impacts of authenticity and environmental sustainability on destination marketing



Piyush Sharma
Marketing

At Curtin University, he is the current Regional Editor (Asia) of the *Journal of Knowledge Management* and researches marketing



Xiaoguang Duan
**Chemical Kinetics
and Catalysis**

At the University of Adelaide, he researches environmental science, technology and green catalysts



Sahil Garg
**Chemical and
Material Sciences**

At the University of Queensland, his research interests include carbon dioxide capture



Zengxia Pei
Materials Engineering

At the University of Sydney, he is working to develop high-performance electrically rechargeable zinc-air batteries



Yan Jiao
**Chemical and
Material Sciences**

At the University of Adelaide, her research aims to design catalyst materials for clean fuels



Jian Zhen Ou
Materials Engineering

At RMIT, he leads a group specialising in research and development of nanotechnology-enabled electronics, photonics and sensors



Seyedali Mirjalili
Artificial Intelligence

At Griffith University, he is a specialist in swarm intelligence and optimisation recognised for introducing new approaches and techniques



Md Mofijur Rahman
Sustainable Energy

At the University of Technology, Sydney his research interests include alternative fuel, IC engine combustion, biofuel and biodiesel



Derrick Wing Kwan Ng
**Computer Networks and
Wireless Communication**

At UNSW, his research interests are green communications, wireless information and power transfer



Mergen Ghayesh
Mechanical Engineering

At the University of Adelaide, his research interests include biomedical robotics, heart attack prediction and sustainable engineering



I. M. Rizwanul Fattah
Sustainable Energy

At UNSW, his interests include sustainable fuel sources and he is researching his thesis on flame-wall interaction in diesel engines



Simon Rosenbaum
Psychiatry

At UNSW, his research focuses on the role of exercise in the prevention and management of mental health disorders



Jian Yang
Genetics and Genomics

At the University of Queensland, his research is in developing novel statistical methods to understand the genetics behind diseases



Joseph Firth
Psychiatry

At the University of Western Sydney, his research investigates novel interventions for improving physical and mental health in young people



Azmeraw Amare
Health and Medical Sciences

At the University of Adelaide, he has research interests in precision medicine, pharmacogenomics and translational medicine



Felix Ogbo
Health and Medical Sciences

At Western Sydney University, his research is in epidemiology, maternal health and child health, and he has a broad interest in global health issues



Marcus Carter
Communication

At the University of Sydney, his research is in human-computer interaction; game studies and animal-computer interaction



Ella Prihatini
Feminism and Women

At the University of Western Australia, her research focuses on Indonesian politics and female representation in Indonesia's political system



Garth Stahl
Gender Studies

At the University of South Australia, his research interest is in theories of sociology of education



Helen Caple
Communication

At UNSW, she is investigating contemporary practices in photojournalism, and the role of picture galleries in online news reporting

Early Achievers Leaderboard Rising stars



Michael Kirchoff
Philosophy

At the University of Wollongong, he researches the naturalistic philosophy of biology and cognitive science, and the philosophy of science



Yuming Guo
Environmental Science

At Monash University, he has developed large global collaborations to assess the impacts of air pollution and climate change on human health



Florian Schaff
Life Sciences, Earth Sciences

At Monash University, his research interests include phase contrast x-ray imaging and synchrotron imaging



Jeremy VanDerWal
Biodiversity and Conservation Biology

At James Cook University, he is director of the Centre for Tropical Biodiversity and Climate Change



Bernd Gludovatz
Life Sciences, Earth Sciences

At University of NSW, he researches the mechanical behaviour of structural materials and analysis of components that fail in service



Md. Joymal Abedin
Sustainable Energy

At Monash University, his research interests are in performance of sustainable alternate fuels. He focuses on biodiesel fuels



Xing-Jiang Zhu
Astronomy and Astrophysics

At Monash University, his research interests are in gravitational waves and combining observations from gravitational-wave detectors



Simon Stevenson
Astronomy and Astrophysics

At Swinburne University, he studies gravitational wave data and what they reveal about the death of massive stars



Eric Thrane
High Energy and Nuclear Physics

At Monash University, he specialises in astrophysical inference using data from gravitational-wave observatories



Qi Fang
High Energy, Nuclear Physics

At the Harry Perkins Institute of Medical Research, he researches and develops new technologies for medical imaging



Paul Lasky
High Energy, Nuclear Physics

At Monash University, he researches gravitational astrophysics and is working on two major gravitational wave research projects



Srecko Joksimovic
Educational Technology

At the University of South Australia, he explores the symbiosis of human and artificial cognition to understand knowledge processes and their impact



Philip Parker
Psychology

At the Australian Catholic University, he focuses on career pathways, educational attainment, and youths' transition from school to work



Nik Steffens
Human Resources and Organisations

At the University of Queensland, he focuses on concepts of self and identity in organisations



Vitomir Kovanovic
Educational Technology

At the University of South Australia, he is a data scientist focusing on new learning analytic systems to improve understanding of learning processes



Maja Folkersen
Environmental Law and Public Policy

At Griffith University, her research interests include environmental economics and climate change

Global warming, food security, obesity and poverty. It's easy to be disheartened by the barrage of negativity in the news and what it means for our country's prosperity. But it doesn't need to be that way.

Every day at Murdoch University I see reason for hope, because the solutions to many of the issues we are facing will come from the bold and inquisitive minds working diligently within the corridors of this and other universities around Australia and the world.

What makes me particularly optimistic is the fundamental nature of the issues that our Murdoch institutes are tackling — food, health and the environment — and the way the research is being approached.

At Murdoch University, we have heeded the government's recent calls for universities to work more closely with industry to convert our research excellence into jobs, new business opportunities and greater productivity.

As Minister for Education Dan Tehan recently said, the research sector and our research capacity will drive growth in our economy. We agree, and we even more strongly believe that we need to turn our discoveries into something that has concrete benefits for Australians.

This is why Murdoch research is very focused on looking at practical solutions to real-world problems, and doing so in conjunction with the businesses and industries which are experiencing issues on a day-to-day basis.

This is evident at the Harry Butler Institute with its focus on the co-existence of business and biodiversity. Researchers and students at the institute are working with the likes of Chevron and their projects, creating real and tangible environmental outcomes for a more sustainable future that balances the needs of industry and the environment.

Meanwhile, over at our Food Futures Institute, the future of our food supply and food security is under the lens. From drought-resistant crops to more efficient and sustainable farming, the breakthroughs from the Murdoch labs are being applied by food producers in Western Australia and nationwide, but also internationally because food security is a global challenge.

Co-ordinating the work of those institutes is the Australian National Phenome Centre (ANPC), the



Murdoch focuses on food, health, environment

only facility of its kind in the southern hemisphere.

The work of the ANPC will potentially change millions of lives. By understanding at a molecular level the way environmental and lifestyle factors interact we hope to better understand and treat diseases such as cancer, Alzheimer's and type 2 diabetes.

Longer term, the ANPC is looking to build global atlases of human disease, providing insights into future health risks from which everyone can benefit.

It's a fundamental contribution to the quest for personalised medicine that treats each person according to Global partners like Bruker have been quick to understand it and get involved.

What's particularly exciting is the way research is taking place. As well as business coming into the research labs as our partners, the research silos across disciplines and institutions are being broken down.

With a focus on food, health and the environment all under the same roof at Murdoch, we are able to share data and insights across these complementary disciplines.

It's a collaborative research approach we think can make a huge difference. When you bring together rich seams of data, leading scientists, sophisticated technology and scientific approaches, with the community partnerships, you really do set the scene for potential and previously unconsidered breakthroughs.

Importantly, it's a research approach that's also appealing to top academics, attracting the likes of professors Jeremy Nicholson and Elaine Holmes, previously at the Imperial College in London, to work at the ANPC.

Students benefit as well. The productive capacity of our nation will rely on educated workers to drive growth and opportunity.

What better for students than having access to the innovation, research and business partners from the leading food, health and environment institutes to draw on?

Not only are we backing the collaboration of our institutes, we want to supercharge it. We give our researchers the time, money and facilities they need to get on with their work, and we want to bring on board more great minds to take part.

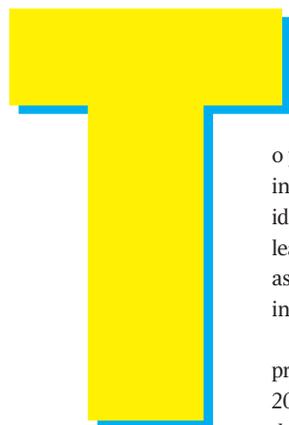
We're conducting a global search to fill 20 new research chairs at Murdoch. The offer to work at Murdoch comes with a guarantee that researchers will be encouraged to think freely, to be inventive and generate translatable breakthroughs to benefit the community we serve.

It's a big commitment, and we're excited to be making it. We really do believe that with this fresh approach, we have an opportunity to solve pressing world problems and positively affect our collective future.

So there are a lot of good reasons for hope.

Eeva Leinonen
VICE-CHANCELLOR
MURDOCH UNIVERSITY

How we did it



o put together the data in this magazine we scanned publicly available information in Google Scholar on all researchers working in Australia to identify the leader in each of 258 fields of scholarship, as well as the leading research institution in each field. We chose to use Google Scholar as our source because it's a rich vein of freely available information, broad in its scope and up to date.

Our methodology took into account both the volume of research produced and its quality. In each field we considered all papers in the top 20 refereed journals in that particular field (which Google Scholar determines using an H-index based measure of journal impact) by researchers in Australian institutions over the past five years. Then we counted the number of citations each paper has received. The top researcher (and the top institution) in each field is the one whose papers have been cited most often. We have considered only those researchers whose first citation was at least 10 years ago, meaning that we are looking at mid and late-career researchers. Our data was largely sourced from Google Scholar in December 2018 and updated in March 2019.

Google assigns these 258 research fields to eight broad disciplinary groups: business, economics and management; social sciences; engineering and computer science; physics and mathematics; health and medical sciences; humanities, arts and literature; life sciences; and chemical and material sciences. We have adopted this structure in the eight main tables in this magazine. We have left out a handful of fields which have little relevance to Australia.

The data was prepared by *The Australian's* partner, research analytics firm League of Scholars. Using this methodology, they were also able to compare Australia's leading researchers with the world's leading researchers. In 14 fields, a researcher from an Australian institution was the world leader and these extraordinary people are listed on Page 8.

The two other major tables in this magazine, the Lifetime Achievers Leaderboard (Page 10) and the Early Achievers Leaderboard (Page 54) are calculated using a different methodology. We have based it on the H-Index — named for physicist Jorge Hirsch who proposed it in 2005 — which is defined as the highest number H such that the given researcher has published H papers which have been cited at least H times. So if a researcher has published 90 papers that each have at least 90 citations, but has not managed to go one better and achieve 91 papers that each have at least 91 citations, then their H-index is 90.

To produce the Lifetime Achievers Leaderboard we used an annualised H-index, which is the H-index divided by the researchers' "academic age" (the number of years since their first citation). Research by renowned bibliometrics scholar Anne-Wil Harzing has shown that the annualised H-Index is the best measure for comparing researchers at different career stages and academics who work in different fields.

The Early Achievers Leaderboard is calculated in a similar way except that only researchers who are within 10 years of their first citation are considered. They also need to have been named as first author on at least one paper in a top 20 journal in a particular field of research. We decided on this caveat to ensure that the early career researchers honoured here have led important work in their own right.

Finally, this year for the first time we have chosen a top multidisciplinary researcher (Page 40). We used a measure of diversity which in economics is called the Herfindahl-Hirschman Index and measures market concentration — it works in this context because diversity is the opposite of concentration — and in biology is called Simpson's Index and measures the diversity of species in an ecosystem. We applied these formulae both to researchers' diversity across broad disciplines and across more fine grained fields of research.

Institution abbreviations

| |
|--|
| Alfred Hospital Alfred |
| Austin Health Austin |
| Australian Catholic University ACU |
| Australian National University ANU |
| Bond University Bond |
| Central Queensland University Central Qld Uni |
| Charles Darwin University CDU |
| Charles Sturt University CSU |
| Commonwealth Scientific and Industrial Research Organisation CSIRO |
| Curtin University Curtin |
| Deakin University Deakin |
| Edith Cowan University Edith Cowan |
| Flinders University Flinders |
| Florey Institute of neuroscience & Mental Health Florey Inst |
| Garvan Institute of Medical Research Garvan |
| George Institute of Global health George Inst |
| Griffith University Griffith |
| James Cook University James Cook |
| La Trobe University La Trobe |
| Macquarie University Macquarie |
| Menzies School of health Research Menzies |
| Monash University Monash |
| Murdoch Children's Research Institute MCRI |
| Murdoch University Murdoch |
| New South Wales Government NSW Govt |
| QIMR Berghofer Medical Research Institute QIMR Berghofer |
| Queensland University of Technology QUT |
| RMIT University Melbourne RMIT |
| South Australian Research and Development Institute SARDI |
| Southern Cross University SCU |
| Swinburne University of Technology Swinburne |
| University of Adelaide Uni of Adelaide |
| University of Canberra Uni of Canberra |
| University of Melbourne Uni of Melb |
| University of Newcastle Uni of Newcastle |
| University of New England UNE |
| University of New South Wales UNSW |
| University of Queensland Uni of Qld |
| University of South Australia UniSA |
| University of the Sunshine Coast USC |
| University of Sydney Uni of Sydney |
| University of Tasmania Uni of Tasmania |
| University of Technology Sydney UTS |
| University of Western Australia UWA |
| University of Wollongong Uni of Wollongong |
| Walter and Eliza Hall Institute of Medical Research WEHI |
| Western Sydney University WSU |

Flinders builds on excellence in health and medicine



One of Flinders University's enduring strengths — health and medical research — will be further bolstered by the formation of Flinders Health and Medical Research Institute and a new purpose-built Health and Medical Research building.

The new Health and Medical Research building provides a vital centrepiece for Flinders Village. The village will add \$1.5 billion in economic value to South Australia and create the largest integrated health, research and education precinct in the State.

Placing such a prominent medical research precinct within a community village setting will serve as a powerful and positive signal that Flinders research is focused on connecting directly with real-world needs. The close proximity between the laboratory and community life that the new precinct will deliver will allow our researchers to be directly connected to where their work makes a difference.

The new institute (FHMRI) will concentrate Flinders' efforts across the key themes of clinical translation, healthy communities and molecular biosciences. The three research themes are headed by outstanding Flinders researchers — with Clinical Translation led by Professor Danny Eckert,

Healthy Communities led by Professor Jon Karnon and Molecular Biosciences led by Professor Damien Keating. These themes bring together 18 existing centres and institutes within the University's College of Medicine and Public Health, creating a critical mass of research aligned with national and international priorities.

It's exciting that this consolidated institute structure will attract and retain the highest calibre research talent and stimulate new opportunities for funding to be developed through external partnerships, especially with industry.

This will happen on the back of Flinders University recently committing an additional \$100 million in research investment over five years, reinforcing its ambition to remain at the forefront of important medical research.

FHMRI will enhance Flinders University's reputation as an internationally recognised centre of excellence in health and medical research, finding scientific solutions to clinical problems across a vast medical landscape and many disciplines. This impetus to innovate through research and implementation has seen Flinders become the home of recognised leaders across many specialised fields.

The launch of the new institute comes on top of

an extraordinarily busy year at Flinders that has drawn together cohesive strengths in many health and research disciplines, achieving innovative responses through expanded collaboration. This includes the launch of the Orama Institute for Mental Health, Wellbeing and Neuroscience, the Caring Futures Institute, the Research Centre in Palliative Care, Death and Dying, and a high-tech \$4 million rejuvenation of Flinders' internationally renowned Adelaide Institute for Sleep Health.

This year has also seen significant developments with Flinders' Medical Device Partnering Program expanding interstate; the Digital Health Research Centre emerging as a leading hub of digital health systems and technologies research; the Australian Institute for Transformative Technology helping industry to embrace new technologies; and the impact of the New Venture Institute, recognised last year as the leading university entrepreneurial incubator in the Asia Pacific region.

The key to Flinders' ongoing research success is the strength of collaborations it fosters. As a leading research and teaching institution co-located with a tertiary hospital, it is the only physically combined facility of its type in Australia — and the introduction of FHMRI within Flinders Village will only strengthen this further.

Through its impressive 50-year history, Flinders has built a powerful international reputation in leading areas of health research — including cancer and oncology (with more than 100 researchers at the Flinders Centre for Innovation and Cancer, Flinders Medical Centre, and across the Flinders University campus); heart and cardiovascular health; neurosciences (having created Australia's first multi-disciplinary centre for neurosciences in 1977); ophthalmology, eye and vision research; sleep health; gut health; as well as research on the social determinants of health and health economics to support health system efficiency and sustainability.

Newer areas in which Flinders is developing research strengths include artificial intelligence and digital health technologies.

In taking the next step by creating FHMRI, Flinders University is ensuring it continues to find innovative solutions to address real-world health and medical problems and build pathways that enable their rapid introduction for the benefit of the entire community.

Professor Ross McKinnon
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