World-leading research in Australia's universities

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Cover images
Front from left: Penny Williamson and Susan Hayes. (Photo: University of Wollongong); A CSIRO ASKAP antenna at the Murchison Radio-astronomy Observatory. (Photo: WA Department of Commerce); Researchers at Cell & Tissue Therapies, Royal Perth Hospital (Photo: Therapeutic Innovation Australia); and Carbon fibre. (Photo: Deakin University).
Back from left: Canola plant at the Charles Sturt University Graham Centre Field Site. (Photo: Toni Nugent); Visiting student Anya with illuminated fibre in fluorescence vial (Photo: University of Adelaide); 3D printing of nerves. (Photo: Australian National Fabrication Facility); and Bimabdn Village, Western Province, Papua New Guinea. (Photo: Julia Colleen Miller).

IV

Senator the Hon Simon Birmingham
Minister for Education and Training

A message from the Australian Government Minister for Education and Training

The health and wellbeing of millions of people around the world depends upon inventions and innovations from the leading-edge research developed within Australia's world-class universities. Such high-quality research can help save lives, protect the environment, raise living standards, drive innovation and create the jobs of the future.

Showcased within this book you will find some of our universities' latest research efforts from across many diverse fields such as astronomy, medicine, agriculture, food technology, earth science and engineering. In some areas, Australian research leads the world. In all areas, our researchers can be found working collaboratively with other leading researchers around the world. This book also demonstrates that our universities are building productive partnerships with businesses and industries. This is part of a broader effort across Australia to collaborate with industry and deliver commercial returns from research.

In 2015–16, the Australian Government will spend $9.7 billion on science, research and innovation. Australian businesses and philanthropists also recognise the importance of our researchers, contributing millions more to support research and translate it into products, services and policies that benefit billions of people around the world, and grow our economy.

High-quality Australian research is central to the economic, cultural and social advancement of our nation. From improving the productivity of our agricultural and manufacturing sectors to protecting our health and strengthening and promoting the oldest continuing culture in the world, Australian research reaches into every part of our daily lives.

The quality of research conducted by Australian universities is also critical to the global reputation of our education system. The reputation of our research draws academics and students from around the world to Australia, internationalising our campuses, enriching our communities, creating jobs and contributing to the economy.

On behalf of the Australian Government, I am proud to support the universities, the researchers and the research infrastructure that produce the outstanding research recognised in this publication. This book demonstrates the breadth, quality and impact of Australia's world-class research effort.

Foreword

Research is a defining characteristic of Australia's universities. Indeed, to be recognised as a university, our institutions must demonstrate quality-benchmarked research proficiency in at least three disciplines. This structural prerequisite balances the spread of knowledge with, importantly, the creation of knowledge.

For decades, Australian universities have delivered excellence in research and innovation and have advanced a research culture and system that has been responsible for world-leading breakthroughs. In many cases, these truly transformative innovations and successes were not achieved in isolation but were the outcomes of collaborative research efforts both domestically and internationally.

International research collaborations are a mechanism for knowledge exchange, helping to bring diversity in perspective and approach to solving the challenges of our time and generating new ideas for the future. A culture of collaborative and innovative research among Australian universities and their international peers fosters a reciprocal culture of positive transformation. Collaborations of a global nature create positive impacts not just at the institutional level, but more importantly, throughout the broader community.

We only need to look around us and the technologies we use and rely on in our day-to-day lives to appreciate the momentous value and contribution of international research collaborations. For example, silicone hydrogel contact lenses now account for around half of lenses fitted internationally and were made possible through global collaboration and Australian leadership. It is through these types of linkages that unexpected creativity and developments emerge.

In an era where innovation drives competition, development and national prosperity, and where social, economic, cultural, environmental and political challenges are increasingly diffused across geographical borders, it has never been more critical for research to respond—and lead—in a global vein. Australian universities have an impressive track record in this regard and we must continue to ensure that Australia remains a destination and collaborator of choice.

Universities Australia, the peak representative body for Australia's universities, is deeply committed to emphasising the importance and value of research—at the institutional level and further afield, both domestically and internationally.

We invite you to join with us in continuing to enrich this culture of innovation through collaboration in research. The more we engage globally, the more we all prosper. This must, after all, be the primary objective of research.

Professor Barney Glover
Chair, Universities Australia

Introduction

CSIRO's ASKAP antennas at the Murchison Radio-astronomy Observatory. Photo: Neal Pritchard

Australia's universities are world leaders in research, breaking new ground, pushing the boundaries of our understanding of the world, and inventing the technologies of tomorrow.

World-leading research occurs at universities of all shapes and sizes throughout the country, spanning the sciences, the social sciences, the arts and the humanities.

Researchers in Australia are highly sought after as international collaborators, a factor that demonstrates their standing in the world's research community. They are often recognised through prestigious international awards; for example, 15 have been awarded a Nobel Prize. The nation's research sector is globally connected, and universities actively foster partnerships with leading research institutions in the Americas, Europe and Asia. Despite Australia's geographic isolation, about half of our research output is published with an international co-author.

This is a time of exciting and accelerating change in the world, and Australia's universities are continually making remarkable discoveries. Every day more than a billion people rely on Australian inventions to help improve their lives. The Cochlear implant, the cervical cancer vaccine, the black box flight recorder and Wi-Fi are all Australian inventions that have revolutionised the world.

Many elements provide the foundation for Australia's research success. Our institutions are characterised by strong frameworks and support structures in order to ensure research of the highest quality. We have world-class research infrastructure that is relied on by researchers and industries domestically and internationally. We are highly collaborative: universities link with each other, their local communities and businesses, and organisations worldwide. All these features make Australia a destination of choice for researchers and a sought-after strategic partner.

Research and innovation are rightly recognised as vital to the world's future prosperity and wellbeing. The Australian Government and the nation's universities, research institutions and researchers are all committed to augmenting our research capacity—to break new ground and to respond to the challenges facing our country, the region and the world.

Dr Karlie Neilson, Australian Proteome Analysis Facility, Macquarie University. Photo Dr Naveid Ali

The Cube. Photo: QUT

Excellent research creating change

Australian university research has a formidable reputation in a wide range of disciplines. There are 43 areas of national strength that have been identified through the Australian Government's Excellence in Research for Australia, or ERA, initiative and demonstrate our research breadth, depth and diversity.

ERA provides a comprehensive overview of the quality of research undertaken in universities throughout the nation in an international context. International organisations and researchers are using ERA results to help identify opportunities for collaboration with the very best.

ERA uses a five-point scale with 'world standard', 'above world standard' and 'well above world standard' being the highest ratings. The ratings are determined using a variety of indicators and are moderated by committees of distinguished researchers drawn from Australia and elsewhere. An area of national strength is defined as 10 or more Australian universities being rated at world standard or higher and four or more of them being rated at well above world standard.

Australia's excellent research is bringing about tangible change for individuals, communities and industries. Health and medical research is leading to better results for patients and more efficient healthcare services. Environmental research is leading to better management of the nation's natural resources. Agricultural research is allowing for the production of nutritionally improved foods and providing greater food security for our region. Research in the social sciences is resulting in more effective government policies and improving our understanding of community attitudes and behaviours.

New industries, products and services are also being created as a result of Australian university research. Biotechnology and medical device companies are reaping the benefits arising from innovations developed in the research sector and are marketing the resultant concepts and products to the world. Our mining and resources industries continue to rely on Australian research to stay at the cutting-edge of technology.

Australia's research strengths

Source: Excellence in Research for Australia 2015

BIOLOGICAL SCIENCES
- Ecology
- Genetics
- Plant Biology
- Zoology

CHEMICAL SCIENCES
- Analytical Chemistry
- Inorganic Chemistry
- Macromolecular and Materials Chemistry
- Physical Chemistry (incl. Structural)

COMMERCE, MANAGEMENT, TOURISM AND SERVICES
- Business and Management

EARTH SCIENCES
- Geology
- Physical Geography and Environmental Geoscience

ENGINEERING
- Civil
- Electrical and Electronic
- Materials
- Mechanical

ENVIRONMENTAL SCIENCES
- Ecological Applications
- Environmental Science and Management
- Soil Sciences

HISTORY AND ARCHAEOLOGY
- Historical Studies

LANGUAGE, COMMUNICATION AND CULTURE
- Cultural Studies
- Literary Studies

LAW AND LEGAL STUDIES
- Law

MATHEMATICAL SCIENCES
- Applied Mathematics
- Pure Mathematics
- Statistics

MEDICAL AND HEALTH SCIENCES
- Cardiovascular Medicine and Haematology
- Clinical Sciences
- Human Movement and Sports Science
- Immunology
- Medical Microbiology
- Medical Physiology
- Neurosciences
- Nursing
- Nutrition and Dietetics
- Oncology and Carcinogenesis
- Pharmacology and Pharmaceutical Sciences
- Public Health and Health Services

PHILOSOPHY AND RELIGIOUS STUDIES
- Philosophy

PHYSICAL SCIENCES
- Astronomical and Space Sciences
- Condensed Matter Physics
- Optical Physics

PSYCHOLOGY AND COGNITIVE SCIENCES
- Psychology

STUDIES IN HUMAN SOCIETY
- Political Science

Professor David Lamb teaching in the Smart Farm Innovation Centre. Photo: University of New England

A dynamic and supportive research environment

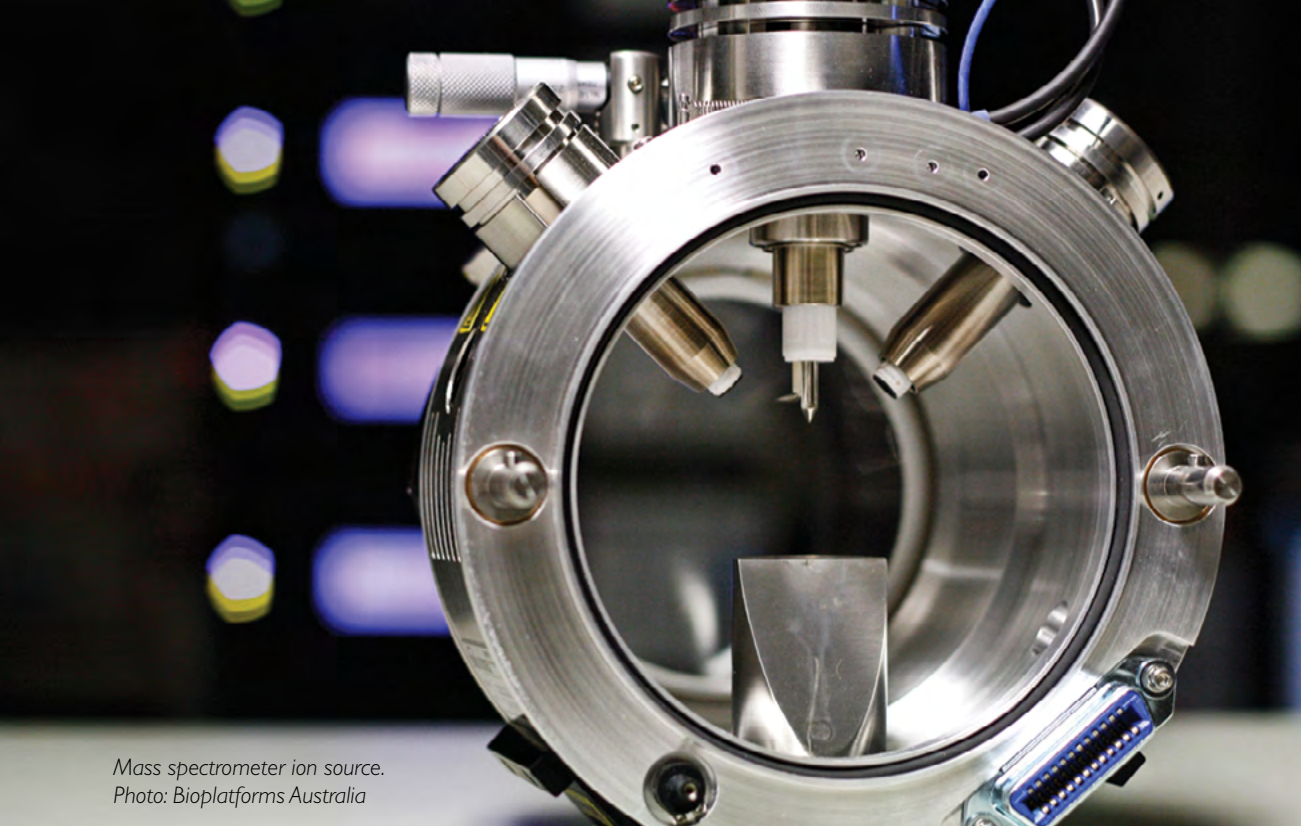
The facilities, support structures and relationships in Australia make our research environment one of the most envied in the world.

Our research leaders are among the world's best, providing a welcoming, rich and dynamic environment for intellectual pursuits. Australian universities are highly multicultural and take pride in providing a supportive setting for international staff and students. The diversity in the sector allows abundant opportunities for researchers to find the best fit for their interests.

Australia's strategic and collaborative investment in research infrastructure has provided a platform for cultural change in the way research is conducted. Through nationally networked facilities, researchers from differing disciplines come together to tackle the challenges that face the nation and the world. These facilities and their specialist staff also provide small, innovative companies and major multinationals with the ability to trial new technologies in collaboration with university researchers.

The research sector consists of a variety of organisations with differing but complementary roles. All of the universities—40 Australian and two international—engage in research. Further, many of our universities have campuses in other countries, and strengthening research connections is a specific objective.

When it comes to world university rankings, Australia has a good track record. None of the rankings provides a complete picture of our universities' strengths, but they



Mass spectrometer ion source.
Photo: Bioplatforms Australia

do demonstrate that Australia has an impressive university system overall. Seven of Australia's universities feature in the world's top 100 universities in the latest QS ranking (2015–16) and 16 featured in the top 100 'under 50' (meaning aged less than 50 years) in the 2015 Times Higher Education ranking results.

A number of government research organisations work with Australia's universities. CSIRO (the Commonwealth Scientific and Industrial Research Organisation) is one of the largest and most diverse research agencies in the world; it has more than 50 sites in Australia and elsewhere. The other large public research organisations are the Defence Science and Technology Group and the Australian Nuclear Science and Technology Organisation. The DST Group is charged with applying science and technology to safeguard Australia and its national interests; ANSTO is Australia's national nuclear research and development organisation.

Other participants in Australia's research system bring together partners to respond to particular questions or areas of research. The Cooperative Research Centres are user-driven research partnerships between publicly funded researchers, business and the community. There are also 15 Rural Research and Development Corporations, covering virtually all aspects of agriculture. The more than 50 medical research institutes in Australia provide a direct link between laboratory-based research and clinical practice.

Destination and collaborator of choice

Australia is a land of dramatic landscapes, cosmopolitan cities and rich heritage. Its unique geography and natural beauty, combined with a dynamic research environment, offer researchers unparalleled career and lifestyle opportunities.

International research organisations, as well as multinationals, seek out Australian researchers and institutions as collaborators. Universities in Australia attach high importance to fostering international relationships, going an extra mile to build trust and shared expertise. Beyond direct partnerships, Australia also has strong links with countries in the Asia–Pacific region, offering collaborators another pathway for engagement.

The Australian Government partners with other countries to support scientific and research collaborations of mutual benefit. It maintains dedicated education and research staff as overseas representatives in key posts. International collaboration is also supported through a range of funding programs, among them those of the two national research councils. The Australian Research Council provides competitive grants for all disciplines other than clinical medicine and health; the National Health and Medical Research Council funds clinical medicine and health research and is involved in more than a dozen international collaborative efforts. International researchers are eligible to apply for funding through an Australian organisation for most funding schemes.

Antarctic ice

Rakini Devi (Doctor of Creative Arts candidate), The Two Madonnas, Mexico City, April 2014. Photo: Niña Yhared

A snapshot of Australian research

This publication provides a snapshot of the range of exciting and innovative research being undertaken in universities in Australia. It is impossible to cover everything that is happening, so we have chosen a number of examples to highlight the talent and diversity in the research sector.

The examples are arranged into themes that demonstrate how research is tackling the many and varied challenges society faces. One of the main purposes of the publication is to highlight the ways researchers collaborate nationally and internationally, delivering amazing results for Australia and our partners. Each theme provides insights into the breakthroughs coming from Australian research, the leading lights in our institutions, and the excellent infrastructure that makes it all possible. In the final section of the publication each of our universities is listed along with a brief summary of its research strengths and the qualities that make it a destination and collaborator of choice.

As will become apparent, in areas as different as the environment, health and communities Australian university research is not just making a difference: it is leading the world.

Health and medicine

Photo: Monash University

Australian universities are renowned for their health and medical research, which covers areas from the fundamentals of biological systems to new drugs, medical devices and therapies, and preventive and community health.

Our universities have formidable expertise in biology and medicine, but integral to the nation's success in health and medical research is our capability in chemistry, physics, mathematics, computer science and materials science.

Health and medical research constitutes Australia's largest and most celebrated research field. The majority of Australian universities are active in the field, and many universities work together to solve global health challenges. Multidisciplinary teams come together from universities, hospitals, independent medical research institutes, government science agencies and industry to tackle these complex problems.

Australian medical research has resulted in internationally recognised breakthroughs. The Cochlear implant, the cervical cancer and influenza vaccines, and spray-on skin for the treatment of burns are just a few of Australia's most noteworthy successes. Among our Nobel prize–winning scientists are Professor Barry Marshall and Dr J Robin Warren (stomach ulcers), Professor Peter Doherty (the immune system) and Professor Elizabeth Blackburn (chromosomes). Internationally renowned medical researchers have also been recognised through the Australian of the Year awards; examples are Professor Patrick McGorry (mental health), Professor Ian Frazer (cancer vaccination), Dr Fiona Wood (burns treatment), Professor Fiona Stanley (public health) and Sir Gustav Nossal (immunology).

The Australian Government has identified health and medical research as a priority area for investment. When it is fully operational, the Medical Research Future Fund, announced in 2014, will see a doubling of the amount of funding available. Beyond this, specific investments in Alzheimer's research, tropical health and diabetes will continue to cement Australia's position as a leader in these areas. The newly announced Biomedical Translation Fund will invest in Australian discoveries and assist in translating promising research into better health and economic outcomes.

Health and medical researchers in Australia have access to excellent facilities and support structures. For instance, facilities provided nationally are enabling excellent genetic research using techniques such as genomics, phenomics and bioinformatics, and imaging and microscopy resources are continually being updated to ensure that our universities are at the forefront of international trends. The creation of a dedicated health and medical beamline at the Australian Synchrotron in Melbourne has also enhanced our capability.

The Tasmanian Devil. Photo: Darran Leal

Cancer and other diseases

Australian researchers are seeking new treatments for infectious and non-infectious diseases such as HIV, cancer and malaria. These diseases are the leading causes of death in many nations, and research into prevention, causes and treatments is a priority throughout the world. Australia's international research partnerships ensure that we remain at the forefront of this research, making discoveries that have an impact on individuals everywhere.

An international collaboration involving researchers from the University of Queensland, the University of New South Wales and the Garvan Institute of Medical Research has identified the mutational processes that prompt tumour development in 30 of the most common cancers. By pinpointing the basic genetic cause of tumour development, this ground-breaking research, the results of which have been published in *Nature*, could have dramatic implications for early diagnosis, treatment and prevention.

Research led by the University of Tasmania is expanding our understanding of an extremely rare type of transmissible cancer, known as devil facial tumour disease, that has affected about 85 per cent of the Tasmanian devil population. The cancer has led to the species being listed as endangered, and extinction is a possibility. Australian researchers are now developing and testing a vaccine with the aim of re-establishing healthy Tasmanian devil populations in the wild. Researchers have also identified a second transmissable facial cancer affecting Tasmanian devils and are working to incorporate this second cancer into the vaccine.

The ithree institute (infection, immunity and innovation) at the University of Technology Sydney brings together an internationally renowned team that aims to improve our understanding and control of infectious diseases in humans and animals. Using the university's Microbial Imaging Facility, which has the most advanced microscope in the world for studying the cell biology of microorganisms, the researchers have recently published ground-breaking results in *Nature*. They have discovered the function of a major group of proteins from an ancient family that is vital for life on earth.

Researchers at the University of New South Wales continue to be at the forefront of therapies and strategies designed to help people with HIV. The Director of the Kirby Institute, Professor David Cooper, has been involved in the development of every existing combination anti-retroviral treatment for HIV on the market. Crucial research done at the institute has persuaded the World Health Organization to recommend earlier treatment for millions of HIV-infected people.

Swinburne's Magnetoencephalography machine. Photo: Swinburne University

Mind and brain

Diseases of the brain and mind now account for more than 40 per cent of all illness. Through basic, translational and clinical research Australian universities are pioneering new approaches to reducing the burden of these diseases throughout the world. In ERA, 18 of Australia's universities were rated as well above world standard in the disciplines of neuroscience or psychology.

Macquarie University is leading Australia's involvement in the Parkinson's Progression Markers Initiative, a study sponsored by the Michael J Fox Foundation. By combining new imaging approaches with collection of biological samples and behavioural data, the initiative aims to identify new biomarkers for future diagnostics, prognostics and treatments. Macquarie University is the only Southern Hemisphere participant in this 32-site global study.

The Centre for Autism Spectrum Disorders at Bond University is a multidisciplinary research and education facility dedicated to assisting people on the autism spectrum as well as their families, caregivers, educators and other professionals involved in their support. The centre was established as a result of the great demand for evidence-based and specialised treatment programs. For example, it has worked with Education Queensland to devise and implement innovative training for school staff educating high-need students.

Researchers at Deakin University have recently devised a way of diagnosing autism in very young children by assessing their gait. Using a high-tech mat containing electronic sensors, the researchers have successfully measured the footfall and gait of children aged as young as two years, creating a simple test that can be performed in a non-laboratory setting. This breakthrough will enable management and intervention strategies to be delivered earlier and improve the tailoring of treatment.

In partnership with the National Imaging Facility and the Victorian Biomedical Imaging Capability, Swinburne University of Technology has made significant investments in infrastructure for brain and psychological sciences research. The university's multi-modal centre houses state-of-the-art neuro-imaging facilities, including facilities for magnetic resonance imaging, magnetoencephalography, electroencephalography and trans-cranial magnetic stimulation. These facilities, and the associated expertise, will place Swinburne at the forefront of efforts to better understand brain function in health and disease.

La Trobe Institute for Molecular Science. Photo: Nils Versemann, Shutterstock.com

Fundamental bioscience

Expanding our knowledge of fundamental biological processes is integral to improving health and wellbeing. Australian universities are taking advantage of our world-class research infrastructure to shine a light on the most basic building blocks of all living organisms. Researching the dynamic and complex nature of living systems requires expertise in a range of disciplines and is central to the creation of new treatments and medical devices.

The ARC Centre of Excellence in Convergent Bio-Nano Science and Technology is a national innovator in bio-nano sciences, bringing together Monash University, the University of Melbourne, the University of Queensland, the University of New South Wales and the University of South Australia, along with partner organisations from around the world. The centre has assembled a variety of expertise, spanning chemistry, pharmaceutical science, biomedical imaging, diagnostics, systems biology and social theory. Researchers are pushing the boundaries of nanomedicine, seeking new ways to target drugs to a tumour or an affected organ while having minimal interaction with other cells.

The La Trobe Institute of Molecular Science is a global research leader in molecular science, biotechnology and nanotechnology, and its research is making an important contribution to Australia's emerging bioeconomy. Working with industry partners, the institute is developing vaccines, therapeutic and diagnostic products to help offset the increasing cost of medical treatments. Researchers at Murdoch University draw on its established record in basic life sciences to investigate the interactions between adaptable pathogens, drugs and the human host to develop personalised and precise interventions.

The University of Melbourne's Bio21 Molecular Science and Biotechnology Institute is a multidisciplinary centre for research in the medical, environmental and material sciences. The institute supports a number of world-leading technology platforms that are providing unprecedented insights into the functioning of cellular systems as well as the tools for translating new findings into therapies. The institute is also the centre of innovation for Australia's largest biopharmaceutical company, CSL Limited, providing a direct link between the university and industry.

Photo: University of Canberra

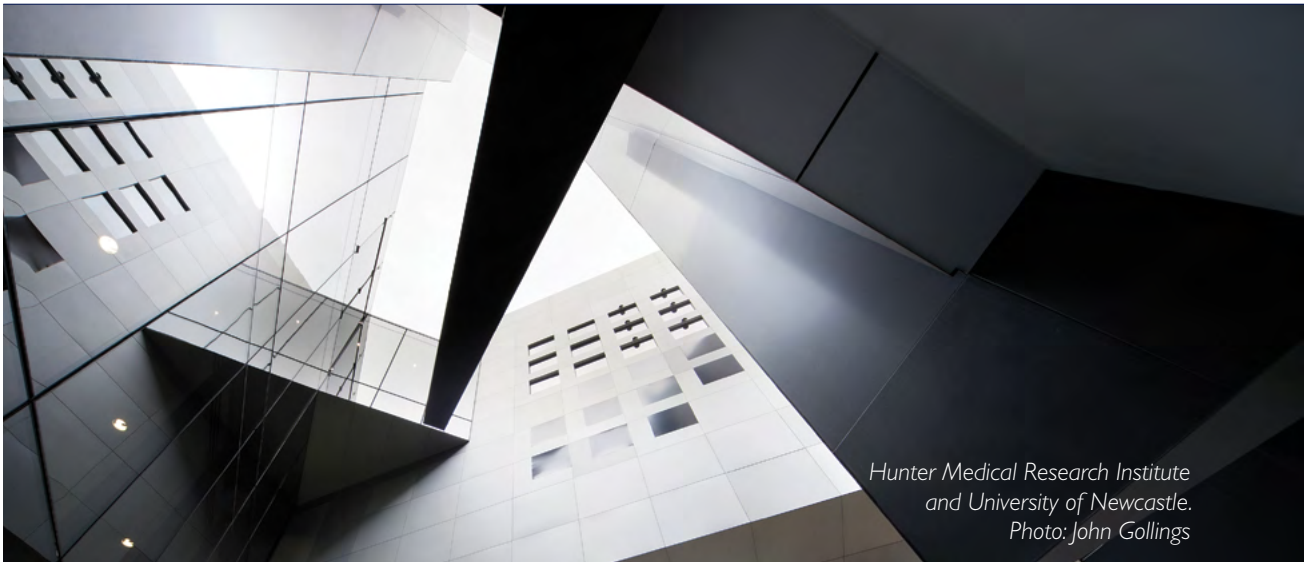
Sports medicine and exercise science

Research into sports medicine and exercise science focuses on the integration of exercise and physical activity into healthcare, sports performance, disease and injury prevention and rehabilitation. Australian universities are at the forefront of this field and have some of the most comprehensive sport and exercise science facilities in the world.

Research conducted at the Institute for Sport, Exercise and Active Living at Victoria University spans the sport and active living spectrum, from participation to high-performance sport, building on close partnerships with global leaders such as the Australian Institute of Sport. The institute is leading the field when it comes to understanding the relationships between exercise, physical activity, and chronic disease prevention, including the mechanisms whereby exercise can prevent, reduce or reverse disease progression.

The Australian Centre for Research into Injury in Sports Prevention, based at Federation University Australia, has been recognised as Australia's premier research centre for sports injury prevention, being one of only four such centres worldwide to be selected by the International Olympic Committee as a member of its Medical Research Network since 2010. Its researchers have particular expertise in injury epidemiology and prevention and clinical sports medicine. The centre has forged strong collaborative relationships with industry and peak bodies; examples are the Australian Football League, the Australian Rugby Union, Cricket Australia, Sports Medicine Australia, the Australian Olympic Committee and the Australian Institute of Sport.

Taking advantage of its proximity to the Australian Institute of Sport, the University of Canberra has established the Research Institute for Sport and Exercise. Researchers there are drawing on expertise in psychology, physiology, biomechanics and coaching pedagogy to advance Australia's high-performance sports research.



Hunter Medical Research Institute and University of Newcastle. Photo: John Gollings

Health services and connections with the community

Health services research is a multidisciplinary scientific field that brings together health and medical and social science researchers in collaboration with institutions engaged in the delivery of health services. A particular focus is the delivery of and access to care that is essential to achieving better health in the community.

Australian universities are pioneering new approaches through their partnerships with local health services. For example, the University of Newcastle has direct access to health service organisations and the community through the Hunter Medical Research Institute, a multidisciplinary partnership between the university, Hunter New England Local Health District and the community. Clinical trials are an integral part of the model and the institute's building has its own clinical trials centre, which is designed to relieve pressure on hospitals and provide easy access to monitoring equipment for patients.

Similarly, the Southgate Institute at Flinders University works closely with a range of organisations—including those providing sexual health, community housing and Indigenous health services—to improve clinical practice. The university's researchers have also been instrumental in the design and building of eight 'smart living' apartments, which are purpose-built with cutting-edge assistive technologies for people with disabilities.

The University of Adelaide's Robinson Research Institute houses a collective of internationally renowned researchers in human reproduction, pregnancy and child health, developing interventions to improve health outcomes for mother and child in pregnancies complicated by obesity and diabetes. One of its research priorities, Born too Soon, is improving outcomes for babies born before term and aims to accurately predict and prevent pre-term birth.

Examining risk factors such as genetic markers, immune parameters and lifestyle factors, the institute is involved in ground-breaking research that will improve the lives of families around the world.

Patient consultation at the Charles Perkins Centre with Associate Professor Amanda Salis and Alice Gibson, PhD Candidate. Photo: University of Sydney

Combating diseases on the rise

It has never been more important to find solutions to obesity, cardiovascular disease and diabetes. These conditions are often approached from a medical perspective, concentrating solely on their biology. In contrast, the Charles Perkins Centre at the University of Sydney brings together outstanding minds to improve our understanding of the impact of other factors on these conditions—for example, psychological make-up, education, cultural norms, economic pressures, the built environment, and the agricultural and food industries on which we depend.

The centre combines the university's best minds in the medical sciences with experts from the arts and social sciences, architecture, business, education and social work, engineering and IT, and the physical, life and environmental sciences in a collaborative environment. The researchers look at problems from all angles, with the goal of creating healthier, more sustainable communities.

At the heart of the centre is a state-of-the-art research and education facility, funded by the University of Sydney and the Australian Government, with technologies that connect and support participating researchers in the university's metropolitan and rural campuses.

CASE STUDY

Linear accelerator section of the Australian Synchrotron. Photo: ANSTO

Melbourne's critical mass of biomedical excellence

The sheer number of life sciences research facilities, researchers, teachers, and undergraduate and postgraduate students in the Parkville biomedical precinct and surrounds and the breadth of bioscience disciplines are without parallel in the Southern Hemisphere. In fact, this is one of very few such concentrations of research excellence worldwide.

About 10,000 scientists, clinicians and technical staff are engaged in biomedical and healthcare research, practice, teaching and training in the precinct. Among the research institutions are the University of Melbourne, Monash University, the Walter and Eliza Hall Institute of Medical Research, the Murdoch Children's Research Institute, the Florey Institute of Neuroscience and Mental Health, and CSIRO. This co-location of hospitals and research institutions in Parkville facilitates collaboration between clinicians and researchers.

Organisations in the precinct have created and commercialised numerous medical and technical innovations—for example, the bionic ear, colony stimulating factors, Relenza®, Recaldent®, retinal imaging, the discovery of Rotavirus, and the development of vaccines, diagnostics, microsurgical instruments and antibiotics. Melbourne is home to many of Australia's biotechnology companies, including CSL Limited, which is in Parkville. This depth of expertise has been instrumental in attracting corporate giants to Melbourne, among them Mesoblast, Acrux, Biota and Starpharma.

CASE STUDY

Monash Vision Group's bionic eye.
Photo: Monash University

The gift of sight

Thanks to two ambitious research projects being carried out in Australia, there could be light at the end of the tunnel for some people with untreatable clinical blindness and vision impairment.

The Monash Vision Group, a collaboration between Monash University, Alfred Health, MiniFab and Grey Innovation, has developed a direct-to-brain cortical prosthetic prototype device—a bionic eye. The eye uses a digital camera mounted on glasses to capture images before transferring them to a vision-processing device. Once processed, the image is wirelessly transmitted to the brain, where it is received by a number of tiny tiles, each the size of a small fingernail, that are implanted in the brain's visual cortex. Because the device bypasses the retina and the optic nerve, it might be able to restore sight to people with macular degeneration, glaucoma or ocular disease.

In parallel researchers and clinicians from Bionic Vision Australia, a consortium that includes the University of Melbourne, the University of New South Wales, the Bionics Institute, the Centre for Eye Research Australia and Data61, has developed a bionic eye consisting of a camera that is attached to a pair of glasses and transmits radio signals to a microchip implanted in the eye. Electrodes on the chip convert the signals into electrical impulses to stimulate cells in the retina. The impulses are passed along the optic nerve to the vision processing centres of the brain, where they are interpreted as an image. This technology aims to address degenerative disorders of the eye including retinitis pigmentosa and age-related macular degeneration.

CASE STUDY

Leading the way on Indigenous health

Through the Menzies School of Health Research, Charles Darwin University is a national and international leader in Indigenous and tropical health and medical research. The Menzies School is Australia's only medical research institute dedicated to improving Indigenous health and wellbeing; it also works with Australia's neighbours in the Asia–Pacific region to respond to global health concerns.

Menzies works at the front line, partnering with more than 60 Indigenous communities in Australia. Internationally, it works in more than 20 countries in the Asia–Pacific region. The research covers many areas—for example, mental health, nutrition, substance abuse, child health and development, and chronic conditions such as cancer, kidney disease and heart disease. In view of its proximity to the Asia–Pacific region, Menzies is also helping Australia's neighbours treat and eliminate malaria, tuberculosis, pneumococcal disease, rheumatic fever, melioidosis and child malnutrition.

For every dollar the Menzies School spends it creates three dollars in savings to public health spending.

There is no quick fix in Indigenous health, but slowly, surely, we are gaining ground.

We are doing research that matters and working in partnership with Indigenous people to deliver results that will change how services are delivered in communities, health services and hospitals. Our work is having a meaningful, measurable impact and improving the lives of hundreds of thousands of people.

Professor Alan Cass
Director, Menzies School of Health Research

Dr Gabrielle McCallum examining a baby with acute bronchiolitis. Photo: Charles Darwin University

CASE STUDY

Food and agriculture

High-throughput phenotyping Smarthouse at The Plant Accelerator®, University of Adelaide. Photo: LemnaTec GmbH

Food security is a fundamental challenge facing the world, and the question of how to improve the productivity and sustainability of all agricultural industries is important to Australian researchers.

Australia is globally recognised as an innovator in agricultural production through its wide-ranging expertise and ability to apply new technologies. In the agriculture, fisheries and forestry sector, research and development has helped Australian agriculture double its productivity in the past 25 years.

Research in Australian universities focuses on important aspects of food and agriculture—for example, adding value to production, effectively managing natural resources, and responding to the threats of climate change and invasive species. We have national strengths in plant biology, evolutionary biology, and environmental science and management. Our universities also excel in areas such as crop and pasture production, veterinary science and forestry. Professor Graham Farquhar was awarded the Prime Minister's Prize for Science in 2015 for transforming our understanding of the world's most important biological reaction—photosynthesis.

Australia's success in this field has been achieved through strong partnerships between universities, governments and industry. The various Cooperative Research Centres and Rural Research and Development Corporations cover virtually all the food and agricultural industries. The CRCs have developed important new technologies, products and services; in the case of the RRDCs, the Australian Government provides dollar-for-dollar matching of industry contributions, adding considerable value to the economy and local communities.

Our understanding of how to harness the natural environment is greatly improving as a result of new approaches to mapping Australia's soil quality, water flows and climate variability. Research infrastructure is delivering real-time information to researchers and is creating whole genome sequences for important crops. For example, there is a nationwide project collecting genetic information about soil microbial communities, creating a reference map that can be linked with other data. This map is augmenting ecological knowledge of the Australian continent and enriching land management strategies.

Photo: University of Queensland

Growing our future

Research investment is required to produce as much food in the next 40 years as we have produced in the previous 10,000 years. Researchers at Murdoch University are involved in all areas of food security, from improving production, quality and storage to biosecurity policies. The university has particular expertise in animal production and nutrition and has links to the Sheep CRC and meat quality programs at the RRDC Meat and Livestock Australia. By investigating how zoonotic diseases are spread, researchers are also helping farmers in South East Asia develop control programs that are cost-effective and culturally sensitive.

Charles Sturt University is a leading player in international research in agricultural, veterinary and environmental science. Its Graham Centre for Agricultural Innovation, in alliance with the New South Wales Government, is improving the lives of rural communities through research, development, extension and training activities that focus on mixed farming systems. The ARC Industrial Transformation Training Centre at Charles Sturt is training the next generation of grain scientists and producing high-quality results for the grains industry. Research projects focus on cereals, pulses and canola and investigate both human and animal uses of grains. The centre is a partnership between the university and several organisations, among them Sunrice and GrainGrowers Ltd, as well as a number of RRDCs.

The density and diversity of agricultural production systems surrounding CQUniversity's regional campuses foster close links with industries and primary producers in Bundaberg, Australia's biggest vegetable production region, and Rockhampton, Australia's beef capital. Industry-focused research work spans post-harvest fruit quality, irrigation efficiency, precision horticulture and livestock management.

Southern Cross University researcher Steven Purcell and Kiribati Fisheries officer delivering training. Photo: Simon Foale, James Cook University

For example, university researchers collaborated with industry to develop a hand-held non-invasive device for assessing the eating quality and maturity of tree crops such as mangoes. Using this device, farmers can assess fruit-eating qualities other than sweetness, such as dryness, acidity, firmness and starch content.

Southern Cross University is involved in several international projects designed to improve the livelihoods of farmers and fishers in the Asia–Pacific region. With assistance from the Australian Centre for International Agricultural Research, the university is helping to rehabilitate degraded catchments in Fiji and Vanuatu and providing information on and training in post-harvest processing to fishers in Tonga. In the Philippines the university is working with international partners to improve the rehabilitation of crucial watersheds and so assist with sustainable land use. ACIAR also supports the University of the Sunshine Coast in carrying out a wide range of international research projects in aquaculture, horticulture and forestry in developing countries.

The University of Southern Queensland has world-class research groups in climate science, irrigated agriculture and engineering in agriculture. Industry gains of more than half a billion dollars a year are attributed to advances in agricultural systems and technology developed by the university. Working with the RRDCs, the university is improving industry productivity and profitability, affecting more than 1,000 cotton farms, 4,000 cane farms and an estimated 20,000 wheat growers. The university's research has led to water use efficiencies for the cotton and horticulture industries, saving hundreds of millions of dollars each year.

CASE STUDY

Professor David Lamb with a drone. Photo: University of New England

SMART farming

With 7,000 sheep and 100 cattle, a SMART Farm in rural Australia is helping researchers from the University of New England take precision technologies straight to the rural sector. UNE is internationally recognised as one of Australia's top universities in agricultural science, and its regional location in New South Wales reinforces its links with the farming community.

The SMART Farm (or Sustainable Manageable Accessible Rural Technologies Farm) is a collaboration between the university, CSIRO, and numerous large and small enterprises. Technologies developed by researchers to improve crops, pasture and livestock management are tested at the farm, providing real-time data for farmers and scientists.

Data gathered from an array of sensors and weather stations on the farm create a living map of growing conditions, collecting and sending information about soil moisture, plant growth and coverage, temperature, air humidity and winds. This information offers valuable insights into plant, soil and climate interactions at various scales, improving our understanding of things such as when to fertilise, sow seed or move cattle. Farmers can monitor cattle behaviour through GPS collars and ear tags; this gives them important health information—for example, when a cow is giving birth or is unwell. SMART Farm data is also being used in classrooms across Australia to inspire the next generation of agricultural scientists and farmers.

CASE STUDY

AgBot II. Photo: QUT

Robots, a farmer's best friend

Agriculture, humankind's oldest and most important economic activity, is receiving a helping hand from one of our newest endeavours—the field of robotics.

QUT is applying its world-leading robotics expertise to create robots that will plant, weed, maintain and harvest crops, further developing precision agriculture and potentially transforming farming.

QUT's AgBot II prototype is a lightweight robot with sophisticated algorithms that extract information on weed, soil and crop conditions from multiple sensors. Designed to work in autonomous groups, AgBot II will help reduce losses in agricultural production through weed control and improve environmental outcomes. AgBot II will also apply fertiliser for site-specific crop management, assessing soil and crop condition to determine fertiliser needs.

QUT researchers are also working with research robots, a Baxter and an Adept Guiabot, to develop technologies to enable robots to interpret their environment using vision. The research will allow robots to work safely alongside humans within complex and changing environments. They have already taught Baxter to use its computer vision to identify and pick red capsicums from plants.

CASE STUDY

Photo: Nutrafruit Pty Ltd

Food as medicine

Purple foods could be the key to unlocking obesity, high blood pressure, cardiovascular disease and a host of other health problems, according to research done at the University of Southern Queensland.

The Queen Garnet plum, grown in Southern Queensland and tested by USQ, has up to five times the levels of anthocyanins found in other types of plums. As anti-inflammatory agents, anthocyanins are very effective against obesity. Testing has also shown that purple plum juice can reverse problems such as high blood pressure, fatty liver and abnormal blood sugar concentrations.

The Queen Garnet plum has had its first commercial harvest at a 75,000-tree orchard and has the potential to provide great benefits to the people of the region and elsewhere.

CASE STUDY

The DNA of a good drop

Researchers at the University of Adelaide have a nose for what makes a good glass of red wine. More than half of Australia's wine and grape research capability is concentrated near the university, the researchers enjoying close proximity to some of the world's best wine regions.

Researchers are active throughout the entire value chain of wine—from understanding the interactions of vines with the environment to sensory research and consumer preferences. In 2015 the university launched the ARC Training Centre for Innovative Wine Production, working closely with Australian and international companies. The university is also part of the Wine Innovation Cluster, which brings together CSIRO, the Australian Wine Research Institute and the South Australian Research and Development Institute.

In collaboration with Bioplatforms Australia, which provides state-of-the-art research infrastructure in the 'omics' field, the Wine Innovation Cluster is pioneering new approaches to industrial yeast characterisation and development through metabolomics and systems biology. This research provides insights into the wine industry and other yeast-based manufacturing, while also providing a working example of the advantages and challenges of a systems-based approach to scientific discovery.

Cultures and communities

Australopithecus sediba. Photo: Brett Eloff, courtesy of Professor Lee Berger and Wits University

Research into cultures and communities aims to interpret the human experience—discovering, preserving and communicating about the past and present to enable a deeper understanding of society.

From literature to the performing arts, history and philosophy, a knowledge of the humanities helps develop informed and critical thinkers. In addition, the development of effective policies is dependent on the knowledge the social sciences provide. Working in partnership with other disciplines, these fields of research create vital insights that are central to delivering real-world outcomes.

Australian universities are home to scholars who are internationally acknowledged experts in the cultural, economic and political systems of the Asia region and the world. Our national strength in historical studies is complemented by our excellence in fields such as law, archaeology and language studies. Australia is also at the forefront of new approaches to understanding how the digital age is changing our social and economic environment.

Research in these fields is embedded in communities and answers a deep need to understand our identity. Communities throughout the world are making use of legal, historical, genealogical and social databases that have been made possible through the work of researchers and cultural institutions. Further, Australia's relationship with our Asia–Pacific neighbours is enriched by our researchers' commitment to studying and better understanding societies' histories, customs and beliefs.

Australian researchers have access to research infrastructure of the highest quality, enabling them to assemble, combine and analyse information and produce holistic answers to complex questions. Our eResearch infrastructure provides all the tools needed for cutting-edge analysis and links collaborators in virtual communities nationally and internationally.

Professor Nicholas Evans and Jimmy Nébni holding a village meeting in Bimadbn, Papua New Guinea. Photo: Julia Colleen Miller

Understanding our world

The Hawke Research Institute at the University of South Australia is recognised as Australia's largest and most innovative social science, creative arts and humanities institute. Researchers work to tackle contemporary social problems, crossing disciplinary boundaries to investigate matters such as child protection, gender and violence, and education and literacy. The institute's research on mobility and migration is supported by the European Union (in the form of the Hawke EU Centre for Mobilities, Migrations and Cultural Transformations) and focuses on the global challenges caused by the increasing displacement of people and communities in the 21st century. The institute is fostering transdisciplinary research of the highest quality while influencing public debate at local, national and global levels.

Aboriginal culture and wellbeing are a particular research strength of the University of Notre Dame Australia, where researchers are exploring the importance of the connections between 'country' and Indigenous peoples' identity, spirituality, community and cultural governance. The university collaborates with national academic institutions, teaching and research communities, governments and industry and has a strong focus on participatory research. The benefits of Notre Dame's research are far-reaching: it has influenced national strategies enabling Indigenous people to transition to higher education as well as providing a framework for national and regional strategic planning. Health outcomes for Indigenous communities in the Kimberley have also been positively impacted by the work of the Nulungu Research Institute.

The world-class expertise of archaeological researchers at La Trobe University is helping unravel the mysteries of our past. These researchers are responsible for several important archaeological breakthroughs, among them finding significant

Xi Hsu working on his final exhibition in the UOW Postgraduate studio. Photo: University of Wollongong

early human remains in South Africa. La Trobe is also home to one of the world's few magnetics laboratories, which has a focus on archaeological and fossil records. The lab is part of a Melbourne-based research network in African palaeoanthropology and evolution that links researchers from La Trobe University, Monash University and the University of Melbourne. In collaboration with partners such as the University of Johannesburg and the University of Liverpool, researchers are doing fascinating archaeological work in South Africa, Malawi, Kenya, Ethiopia, Israel, Armenia, Bulgaria and Australia.

The Australian Catholic University is one of Australia's leaders in religious studies. Its research ranges from biblical studies to moral philosophy and the phenomenology of religion. Researchers investigate fundamental questions associated with what it means to be human, extending the traditional fields of philosophy and theology to contemporary considerations. For example, they are exploring how cultural mores or power relationships, which are often evident in medical contexts, compromise individuals' autonomy and influence treatment.

The University of Wollongong houses one of the few multidisciplinary schools in Australia that encompasses both pure and applied research in the visual, performing and media arts, creative writing, English and journalism. The school's mission is to inspire creative thinking, learning and art practices through multidisciplinary education and research in contemporary creative arts. One current research focus is nature, networks and events in contemporary arts and the links to social transformation. Researchers at the university are highly regarded both nationally and internationally, and the school produces a variety of high-quality artistic creations.

CASE STUDY

Big History

How did the universe come to be? Where did humans come from? Where are we going? These are questions researchers around the world seek to answer, but one Australian university is taking an innovative approach to understanding the cosmos, Earth and our humanity in an entirely new way.

Macquarie University is the intellectual birthplace of Big History, a field of research that brings together experts from the sciences, social sciences and the humanities to develop a new understanding of the world's history. Researchers at the Big History Institute are weaving together insights from astronomy, anthropology, physics, biology, history and economics to tell a single, understandable story of the universe.

This interdisciplinary approach has attracted the attention of Bill Gates. Big History changed his perspective on history and provided a broad context for understanding many different scientific fields, prompting him to wonder if the course of study could have a similar effect on students. If every student took Big History, would it excite students about learning, be a stepping-stone to intimidating subjects (such as science) and develop critical thinking skills? Gates has now partnered with Macquarie University to make Big History broadly available in school classrooms and online in Australia and the United States.

But the research doesn't stop there. The Big History Institute is continuing to pursue important questions touching many disciplines, allowing researchers to explore projects that cross the three large domains of the physical world, the biological world and the human world.

Professor David Christian, creator of Big History. Photo: Macquarie University

CASE STUDY

CASE STUDY

Photo: The MARCS Institute, Western Sydney University

The dynamics of language

Language is central to virtually everything humans do: we use it to tell the people around us what we feel and what we want and to question and learn more about the world around us. The dynamic nature of languages makes it difficult to understand how they evolve, but researchers at the ARC Centre of Excellence for the Dynamics of Language are investigating this complex puzzle.

The centre brings together philosophers, psychologists and roboticists to explore how our minds acquire and exploit languages to achieve different ends. Languages are investigated from four interrelated standpoints—how they are put together, how they are learnt, how they are processed and how they evolve.

Researchers focus on very diverse topics, such as how it is that children manage to learn languages so quickly, why language evolved, and how to help people with communication disorders. The centre's investigations have led to the development of advanced language-learning robots and technology-assisted dementia treatments.

University partners in the centre are the Australian National University, the Western Sydney University, the University of Melbourne and the University of Queensland. The centre also collaborates with a range of research organisations in the United States, the United Kingdom, New Zealand, China, Singapore, Germany and the Netherlands. One of its priorities is reversing the erosion of linguistic diversity in Australia and Asia: researchers are working on targeted language documentation projects in Australia, Papua New Guinea, Indonesia, Vanuatu, China and Laos.

CASE STUDY

Burglars at work: Shocking suicide at Castlemaine, Image PN02/06/77/00. Photo: Pictures Collection, State Library of Victoria

Digitally transforming criminal studies

A transformation is under way in humanities and social science research. Digital technologies are making research easier and more efficient, allowing for new ways of working, opening up new questions and creating new knowledge.

The Prosecution Project at Griffith University is an example of how Australian universities are at the forefront of this digital revolution. By using modern technology to access the vast archives and media resources available today, the project aims to map the changes in prosecution over time and analyse them in relation to evolving social attitudes.

By digitising records from all Australian states (whose archives are among the most complete in the world) and combining them with other digital resources, the project will provide foundational knowledge of how crime has been prosecuted in Australia. It will also tell us much about Australian history—how people lived, how they behaved, how they dealt with conflict and tragedy, and how legal and political institutions responded to crime and its consequences.

Astronomy and space science

Anglo-Australian Telescope at Siding Spring Observatory. Photo: Fred Kamphues

Astronomy and astrophysics involves the study of everything beyond Earth—planets, stars, galaxies, black holes, dark matter, quasars, cosmology, the Big Bang, and so on. It is through astronomy that we will come to understand the emergence of life and the final fate of the universe itself.

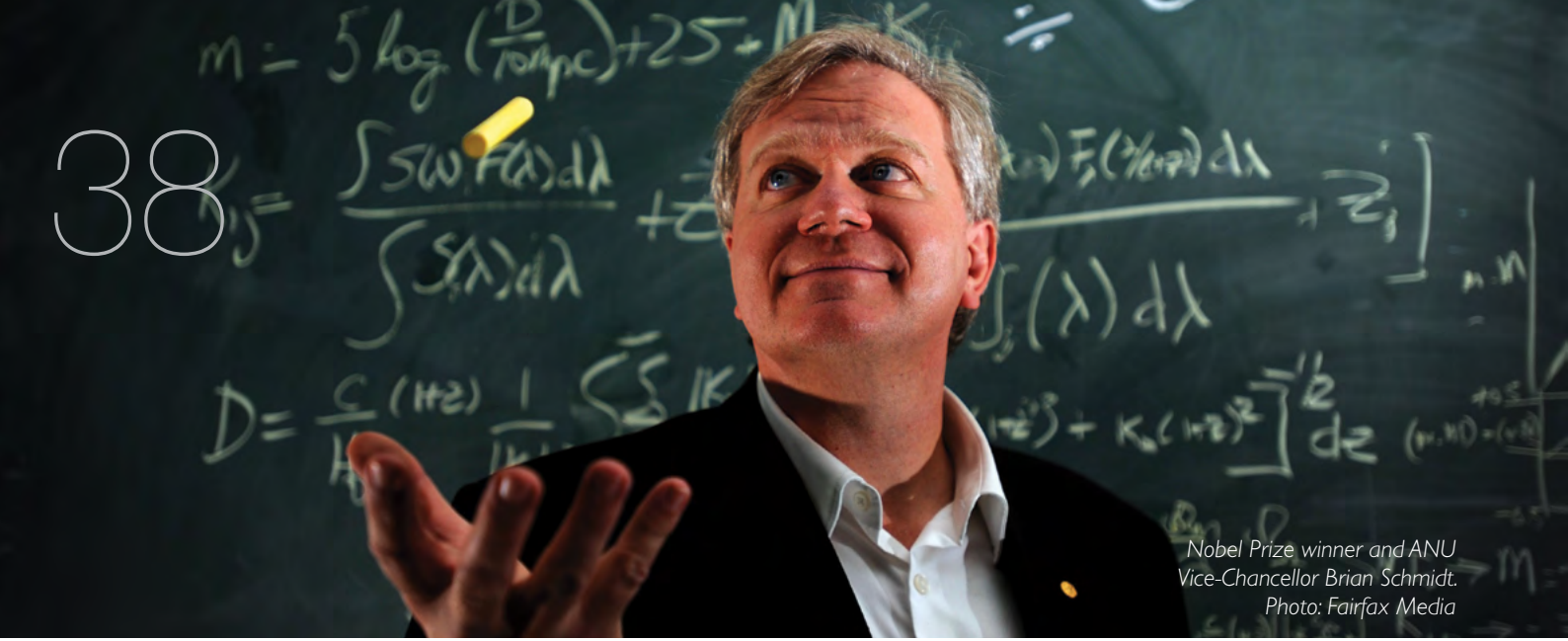
Australia is internationally recognised as a world leader in astronomical research, a reputation that has been built over many years. Our vibrant research community is a central player in global research endeavours and international space missions. And our location in the Southern Hemisphere gives us one of the world's best vantage points for astronomical observation.

Australia has a range of established world-class radio and optical telescopes (such as CSIRO's Parkes and Compact Array telescopes and the Anglo-Australian Telescope) and exciting new instruments (such as the Murchison Widefield Array, the Australian National University's SkyMapper telescope, and CSIRO's Australian Square Kilometre Array Pathfinder). Beyond our domestic capabilities, we have access to leading international facilities (such as the Gemini, Keck, Subaru and twin Magellan telescopes) and we are part of international consortia such as the Square Kilometre Array and the Giant Magellan Telescope.

Astronomical research in Australia covers the entire electromagnetic spectrum, from low-frequency radio waves over infrared, visible and ultraviolet light to high-frequency x-ray and gamma rays. Australian researchers have played leading roles in major astronomical endeavours (among them studies of the large-scale structure of the universe and the discovery of gravitational waves) thanks to their expertise in theory, computation and modelling. In ERA, nine of Australia's universities were rated as well above world standard in astronomical and space sciences.

Along with his collaborators, astrophysicist Brian Schmidt AC, current Vice-Chancellor of the Australian National University, was awarded the Nobel Prize for Physics in 2011 for discovering that the expansion of the universe is accelerating as a result of a mysterious force called Dark Energy.

Australian space scientists participate in a large number of international missions, and our research institutions provide vital spacecraft-tracking and data-download infrastructure for the United States and European space programs. Our researchers benefit from the range of infrastructure investments that provide accessible, accurate and timely Earth observation and positioning data.



Nobel Prize winner and ANU Vice-Chancellor Brian Schmidt. Photo: Fairfax Media

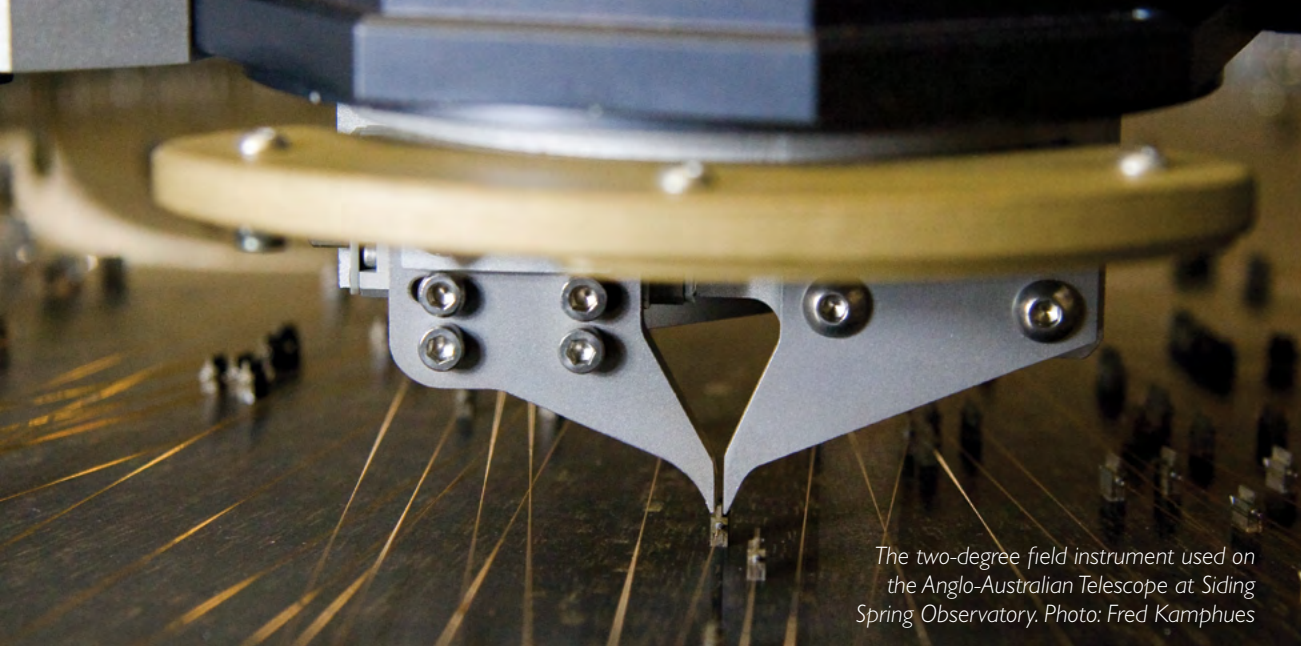
The techniques and technologies of astronomy and space science are intertwined with those of other fields such photonics, materials science, robotics, signal processing, and data visualisation and interpretation. The best example of the benefits of this interrelationship is the invention of Wi-Fi, which came about through CSIRO's pioneering work in radio astronomy and is an internationally recognised Australian innovation.

Understanding our universe

The ARC Centre of Excellence for All-sky Astrophysics, known as CAASTRO, is an international leader in wide-field astronomy. With access to next-generation telescopes and advanced instrumentation, it has brought together unique Australian expertise in radio astronomy, optical astronomy, theoretical astrophysics and computation to look at the sky in a new way. The researchers are developing innovative ways of processing enormous volumes of astronomical measurements and of visualising complex data sets. For example, they have created an instrument based on bundles of optical fibres that is giving Australian astronomers the first 'Google street view' of the cosmos—incredibly detailed views of huge numbers of galaxies.

CAASTRO is uniting Australia's and the world's top astronomers. It has seven Australian university partners, along with CSIRO and the Australian Astronomical Observatory. The international partners include two Max Planck Institutes in Germany, the California Institute of Technology and the University of Arizona in the United States, the University of Oxford and Durham University in the United Kingdom, France's Laboratoire de Physique Nucléaire et de Hautes Energies, India's Raman Research Institute, and the University of Toronto in Canada.

The Australian National University has a long history of research and technical activity at the leading-edge of astronomy and astrophysics. It operates Siding Spring Observatory in New South Wales, which is one of the world's darkest astronomical sites. The observatory is home to many telescopes, among them SkyMapper, the university's state-of-the-art automated wide-field survey telescope that represents a new vehicle for scientific discovery. SkyMapper's



The two-degree field instrument used on the Anglo-Australian Telescope at Siding Spring Observatory. Photo: Fred Kamphues

mission is to robotically create the first comprehensive digital survey of the entire southern sky. The university has a wealth of expertise in a broad range of areas, such as galactic archaeology, cosmology, planetary science, and studies of supernovae and black holes.

Astronomy research at Swinburne University of Technology spans the entire electromagnetic spectrum, and researchers there have expertise in galaxy formation, pulsar surveys, globular clusters, supermassive black holes, Big Bang cosmology and dark matter. They have overturned a longstanding belief that supermassive black holes are always a constant percentage of the mass of all the other stars in their galaxy; instead, they discovered that these monster black holes are hungrier than previously thought, eating so much that they grow faster than the galaxy around them. This discovery was made possible by using data gathered from the Hubble Space Telescope, the Very Large Telescope in Chile and the WM Keck Telescope in Hawaii.

The International Centre for Radio Astronomy Research is a joint venture between the University of Western Australia and Curtin University. Researchers at the centre are involved in frontier astrophysics, using the finest international facilities and the superior data-processing facilities provided by the Pawsey Supercomputing Centre. The researchers are leading important projects on the Square Kilometre Array and its precursor instruments and are promoting the capacity of local industry to support the design, construction and operation of the SKA.

The University of Tasmania continues to have a pivotal role in maintaining and improving the geographic coordinate system for the Australian continent. Through regular observations using very long baseline interferometry, the precise location of the university's 26-metre telescope with respect to other telescopes worldwide has been measured and monitored to centimetre precision. As well as providing important scientific information on the rotation of the Earth, the movement of continental plates and the effects of earthquakes, these measurements provide the fundamental reference frame for all other types of geographic positioning techniques.

CASE STUDY

Saving us from space junk

It might not have George Clooney and Sandra Bullock, but the Cooperative Research Centre for Space Environment Management is aiming to clean up space to make sure we don't experience the kind of event portrayed in the Oscar-winning movie Gravity. The CRC is helping scientists find and track Earth-orbiting debris that could be at risk of colliding with satellites.

Researchers estimate that more than 300,000 pieces of space junk, from tiny screws and bolts to larger parts of old rockets, are in orbit. The junk is mostly moving in low orbits around the Earth, but it is big enough to do serious damage.

The CRC involves a consortium of universities, aerospace industry companies and space agencies, among them the Australian National University, RMIT University, EOS Space Systems, Lockheed Martin, the NASA Ames Research Centre, Japan's National Institute of Information and Communications Technology, and Optus.

The centre's ultimate goal is to hit the space junk with lasers, slowing its orbit and allowing it to fall back into the atmosphere and burn up harmlessly.

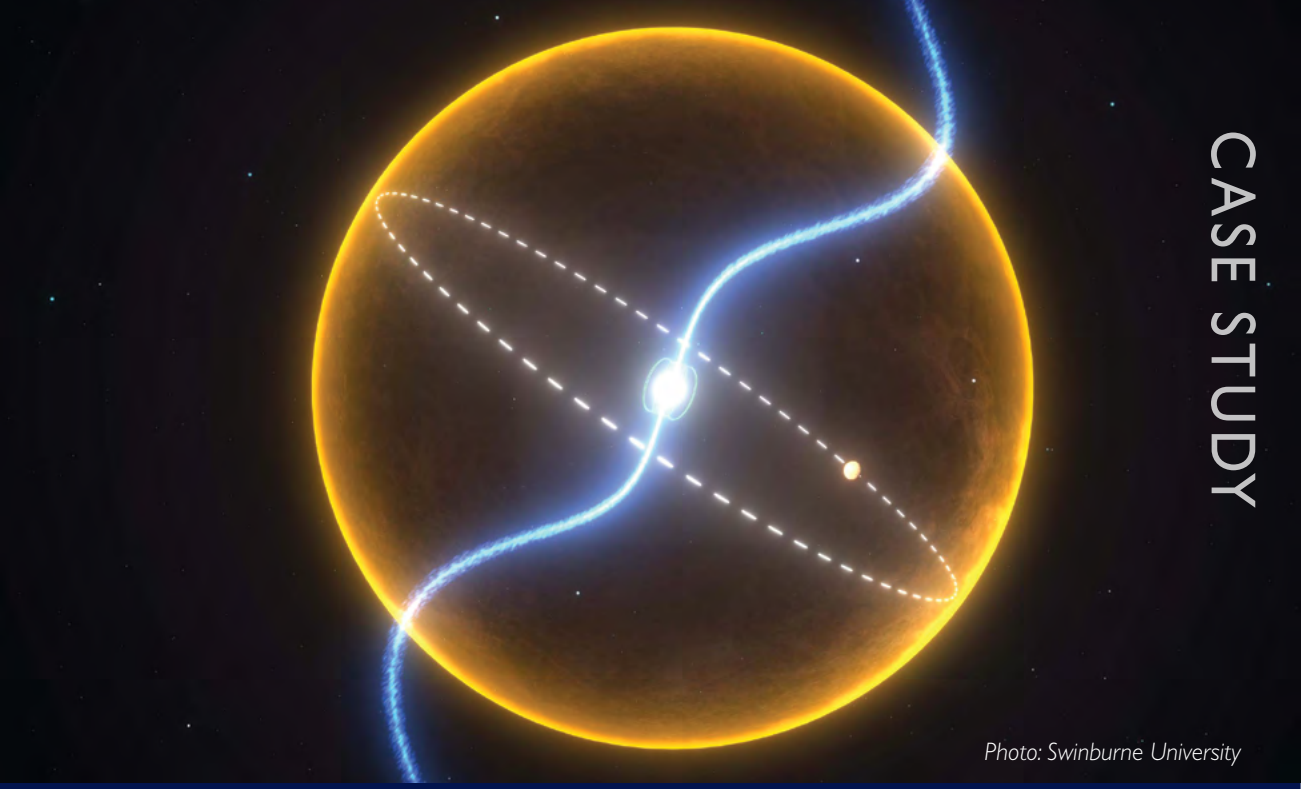


Photo: Swinburne University

The jewels of space

Astronomers at Swinburne University of Technology think they have found a once-massive star that has been transformed into a small planet made of diamond. The researchers, from Australia, Germany, Italy, the United Kingdom and the United States, first detected an unusual star called a pulsar using the CSIRO radio telescope at Parkes in New South Wales and followed up their discovery with the Lovell radio telescope in the United Kingdom and one of the WM Keck telescopes in Hawaii.

On the basis of the modulations in the pulsar's radio waves, the astronomers concluded there must be a small companion planet orbiting the pulsar. Despite its small size, this planet has a slightly greater mass than Jupiter. The team deduced from this density that the planet was probably made of pure carbon—leading to the name 'the diamond planet'.

The team thinks the planet is all that remains of a once-massive star, most of whose matter was siphoned off towards the pulsar. The pulsar and its planet are part of the Milky Way's plane of stars and lie 4,000 light-years away in the constellation of Serpens (the Snake).

Astronomers at Swinburne were also members of an international team that discovered a rare square galaxy with a striking resemblance to an emerald-cut diamond.

CASE STUDY

The Square Kilometre Array, a global endeavour

For more than 20 years astronomers have been contemplating the next big step forward in our understanding of the universe. The remote desert of Western Australia, home to Aboriginal peoples who were arguably the world's first astronomers, could provide for humanity the clearest view of the first objects created—the seeds of the universe we see around us today.

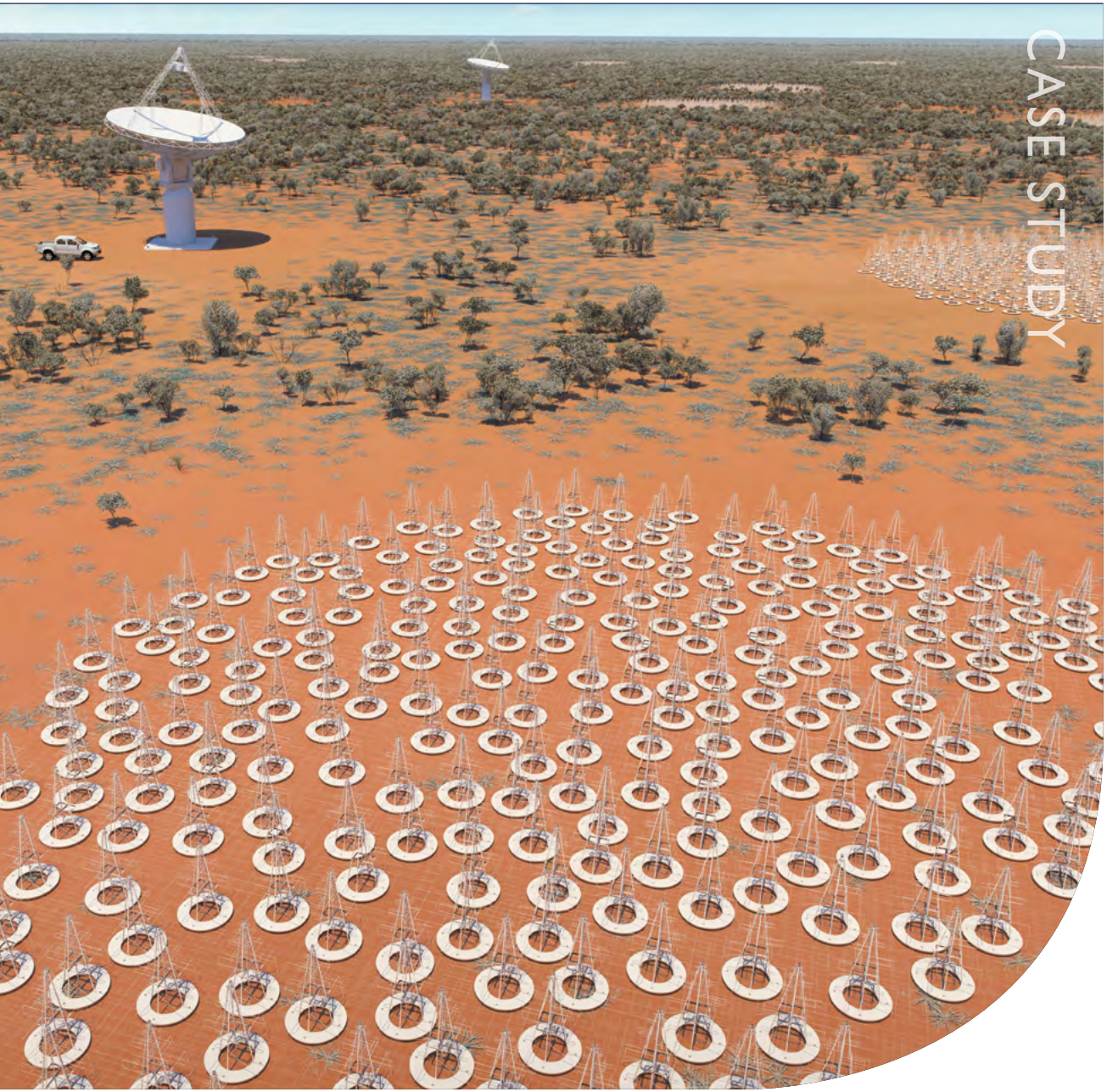
The Square Kilometre Array is a next-generation radio telescope project involving institutions from over 20 countries. It will be the largest and most capable radio telescope ever constructed, helping scientists investigate five fundamental questions about the universe:

- How were the first black holes and stars formed?
- How do galaxies evolve and what is dark energy?
- What generates giant magnetic fields in space?
- Are we alone in the universe?
- Was Einstein right?

The Murchison Radio-Astronomy Observatory, in the Midwest region of Western Australia, is one of two sites selected to host the Square Kilometre Array (the other being in South Africa). The observatory is situated on a 350,000-hectare cattle station in the classic Australian landscape of flat, red plains and deep blue skies. It is ideal for radio astronomy because of its superb radio quietness, upper atmosphere stability, and favourable weather and climate.

Australia has been involved in the Square Kilometre Array since its inception. CSIRO and Australian universities—Curtin University, the University of Western Australia, the University of Melbourne, Swinburne University of Technology and the University of Sydney—have been working in partnership with governments and industry to bring this global science and engineering project to fruition.

Artist's impression of SKA1 wide field low-frequency aperture array. Photo: SKA Organisation/Eye Candy Animation



CASE STUDY

Advanced technologies

Photo: QUT

Australian research is producing technologies that are transforming existing industries and creating the industries of the future. This research is fundamental to economic growth in a broad range of sectors, such as energy and resources, the service industries, health and medicine, security and agriculture.

Industry needs innovative high-value products that are competitive in the global marketplace and technologies that enable more efficient, economical and sustainable ways of doing business.

Using breakthrough technologies, Australian universities are developing innovative solutions to complex technical challenges. This work requires both the development of theoretical and technical knowhow as well as the skills to design, invent, test and apply smart devices. Australian expertise spans the value chain, from the development of new materials to the creation of complete prototypes.

Advanced technologies constitutes a multidisciplinary, highly collaborative area of research, bringing together expertise from the chemical, mathematical and physical sciences, engineering and information technology. A range of ARC Centres of Excellence are bringing together outstanding researchers to push the boundaries of technological innovation. Industry and research organisations are working side by side in Cooperative Research Centres to develop new products, processes and services. The new Industry Growth Centres will help inform the research sector of industry needs and commercialisation opportunities.

Technological breakthroughs made possible by Australian research have changed the world. Among the successes are Wi-Fi, the photovoltaic solar cell, the black box flight recorder, ultrasound, polymer banknotes, continuous-wear contact lenses and the Nanopatch vaccination-delivery device.

The research infrastructure available in Australia is world-class, from fabrication and imaging facilities to clean rooms. The national network ensures that researchers in both industry and academia have access to the expertise and tools needed to perform cutting-edge research. Our facilities have attracted international research partners such as US Department of Defense and NASA and have become portals for accessing Australian science.

Carbon Fibre Pilot Line

New industries

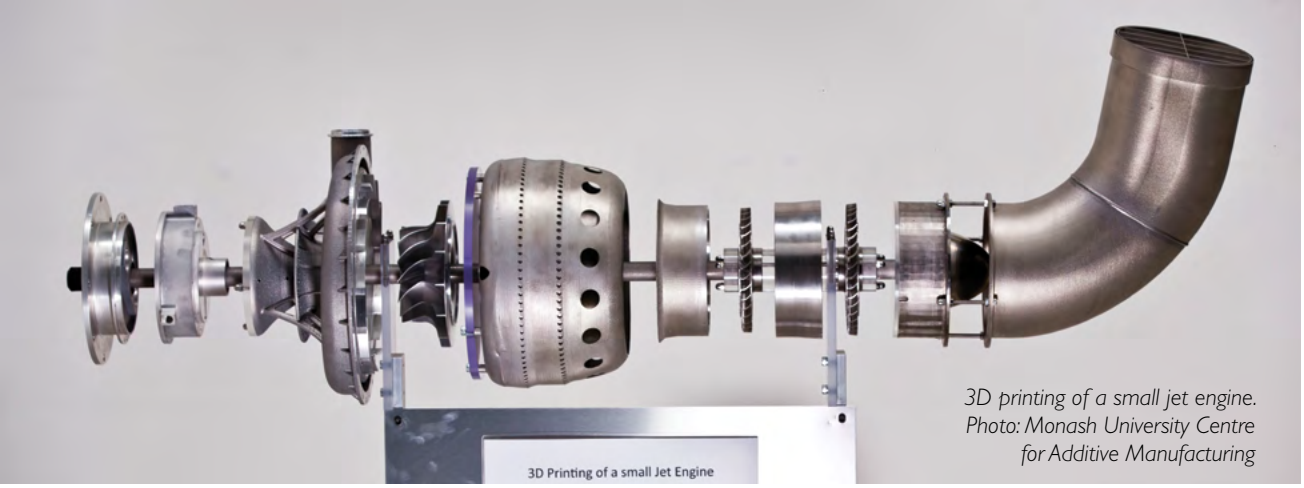
The ARC Centre of Excellence in Robotic Vision aims to build on Australia's enviable reputation in this transformative field. The centre will become a focal point for international activity, partnering QUT, the University of Adelaide, the Australian National University and Monash University with overseas institutions such as the University of Oxford, Imperial College London, ETH Zürich, Inria and the Georgia Institute of Technology. The centre will deliver the science and technologies that will turn cameras in robots into powerful sensing devices capable of understanding and responding to environments that were previously too complex or chaotic for robots.

Deakin University is playing a central role in accelerating the transformation of Australia's manufacturing industry into a vibrant, future fibre–oriented sector. The university is establishing an Industrial Transformation Research Hub in Future Fibres at its Institute for Frontier Materials, building on extensive work during the past two decades in fibre research and development, including establishment of the globally unique carbon fibre research facility Carbon Nexus. The hub will focus on developing novel fibre technologies, working with innovative small and medium enterprises and connecting with international research leaders. Its activities will focus on advanced carbon fibres, nanofibres and high-performance novel fibres.

Research at the molecular and nano scales is playing an increasingly important role in the development of novel medicines, personal care products, foods, materials and industrial processes. Molecular scientists at Flinders University are working with industry partners on projects as diverse as desalination refinement, plastics manufacturing and energy technology. For example, researchers are creating new materials such as photoactive membranes, carbon nanotubes and microbe-resistant coatings.

Both Deakin and Flinders Universities are working in the new area of high-tech security, partnering with the Australian Department of Defence. Researchers at Flinders are pioneering new approaches to fingerprinting with quantum dots and human identification using microfluidics. The Defence Systems Integration and Robotics Lab at Deakin University is developing state-of-the-art technologies for remotely disarming improvised explosive devices.

By harnessing the natural shape of water droplets, a researcher at the Australian National University has invented a way of making microscope lenses that can magnify up to 160 times yet cost less than a cent. The lenses are compatible with many devices, including the smartphone. The mobile phone microscopes could greatly assist science and medicine in developing countries, particularly in the case of remote medical diagnosis.



3D printing of a small jet engine. Photo: Monash University Centre for Additive Manufacturing

Current industries

The aerospace industry is seeking new materials that are lighter, stronger and cheaper to manufacture and that will help halve the industry's carbon emissions by 2050. Monash University is leading the way in the field: one of its projects involves developing a new aluminium alloy that will make aircraft 30 to 40 per cent lighter and twice as fuel efficient, yet still structurally sound. Projects such as this have attracted international aerospace heavyweights as partners, among them Microturbo, the European Space Agency and Bombardier. At the 2015 Australian International Airshow, Monash and its spin-off company Amaero Engineering revealed the world's first 3D printed jet engine, made using a high-powered laser and fused powdered metal.

Since 2007 the University of Sydney has been collaborating with Rio Tinto to develop and implement a fully autonomous remotely operated mine. The collaboration has resulted in a number of major research advances aimed at improving the safety and productivity of such mining sites. One particular advance is the creation of autonomous mining drill rigs, which allow the operator to be located anywhere in the world. The next phase of this work will focus on step-change improvements in safety, predictability, precision and efficiency.

CQUniversity's longstanding research expertise in railway engineering and manufacturing is boosting the competitive position of the rail industry. The university's focus is technologies that integrate data and information systems with real-world industrial and engineering hardware. Important achievements are the development of new technologies for long-haul coal trains, train derailment prediction, real-time monitoring of rolling-stock condition, and advanced traction control systems. Research on intelligent networked systems was instrumental in the university receiving a top rating for applied mathematics research in ERA.

CASE STUDY

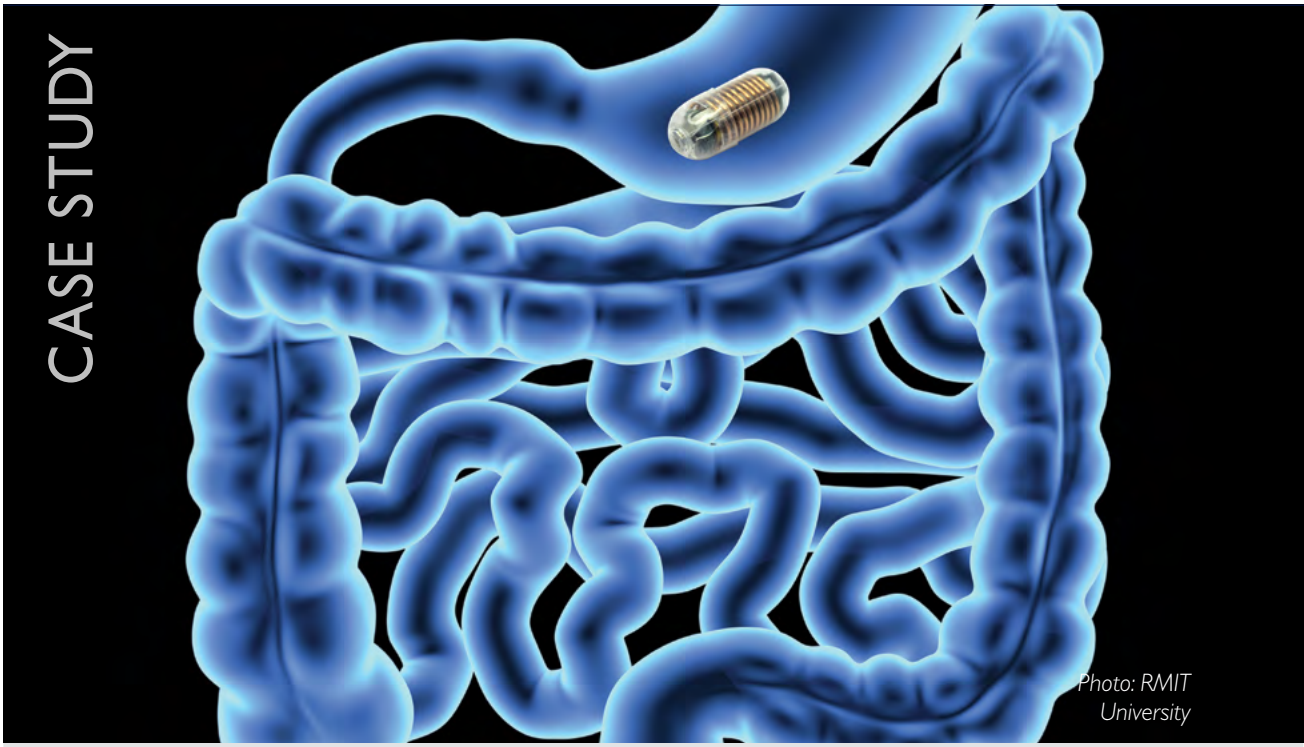


Photo: RMIT University

Hello, it's your digestive system calling

Researchers at RMIT and Monash Universities have developed high-tech gas-sensing capsules that can send data from inside the gut direct to a mobile phone, opening new possibilities for diagnosis, treatment and health analysis. The new technology measures the concentration of selected intestinal gases through a swallowable capsule with a built-in gas sensor, microprocessor and wireless high-frequency transmitter.

Intestinal gases have been linked to colon cancer, irritable bowel syndrome and inflammatory bowel disease and could potentially be used as key biomarkers for assessing overall health. 'With nearly half of Australia's population complaining of digestive problems in any 12-month period, this technology could be the simple tool we need to methodically tailor our diets to our individual bodies and improve our digestive health,' says the project's lead investigator, Professor Kourosh Kalantar-zadeh from RMIT.

CASE STUDY

Photo: Deakin University

OzBots save the day

They might not look like Robocop, but the Deakin University–designed OzBots are proving staunch allies for a growing number of Australian law enforcement agencies.

At only 14.5 centimetres tall, the remotely controlled OzBot was designed by specialists from Deakin's Centre for Intelligent Systems Research and is capable of climbing stairs, carrying a person and even towing a car. Since its genesis several years ago, the OzBot has been joined by a sturdy little brother, OzBot Jnr.

OzBots are already in service in a number of Australian police units, such as the Special Operations Group, the bomb response units and police negotiators. An OzBot was used to bring a 44-hour siege in suburban Melbourne to an end in 2012. OzBots' potential in other fields is also becoming clear, with applications in areas such as domestic law enforcement, aeronautics and environmental management.

CASE STUDY

Computers for the future

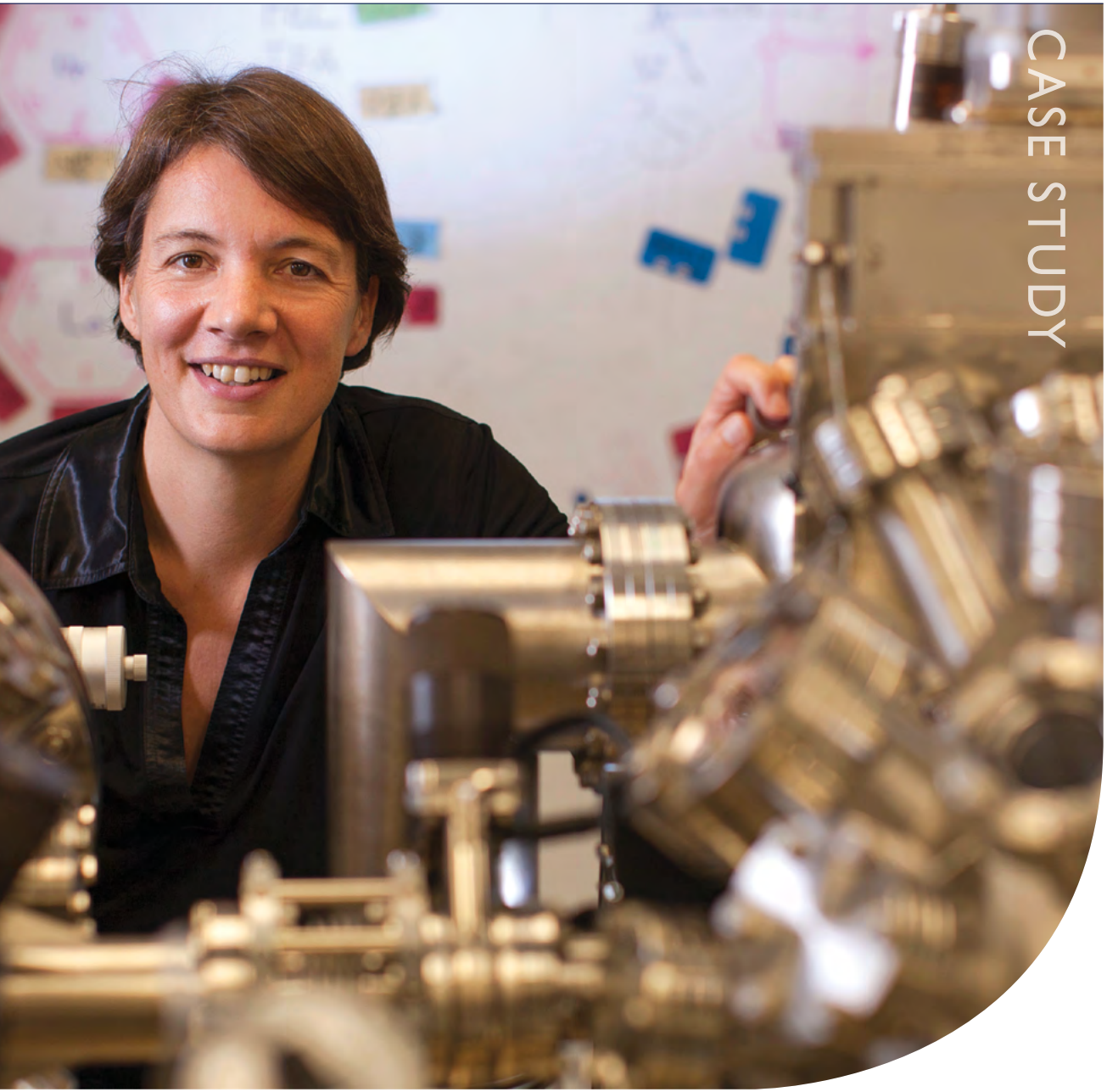
Modern computers use silicon chips to perform an array of complex calculations, but there are still some important problems they are unable to solve because they lack the processing power. For example, no computer as we know it today will ever be able to invent new pharmaceuticals using computer-aided design: that is just too complex. We need a new type of computer—a quantum computer—in which the 'bits' of data used for the calculations are stored on quantum particles, like individual atoms.

Capable of processing information in parallel, quantum computers have the potential to revolutionise entire industries. At the ARC Centre of Excellence for Quantum Computation and Communication Technology researchers from the Universities of New South Wales and Melbourne, led by Professor Michelle Simmons, have achieved a number of important goals in turning the dream of a working quantum computer into reality. They were the first scientists in the world to use a single atom in silicon to create a working quantum bit, a fundamental building block of a quantum computer. Another breakthrough was achieved when they created the world's smallest working transistor: this achievement came 10 years ahead of industry predictions.

Last year, the researchers unveiled the world's first quantum-logic device in silicon, a feat named by the UK's Institute of Physics as one of the top ten scientific breakthroughs of 2015. The teams also patented and published a method to make a full-scale quantum computing architecture, providing a pathway to a practical system.

"The great thing about this architecture is it gives us an endpoint. We now know exactly what we need to do in the international race to get there first," Professor Simmons says.

Professor Michelle Simmons. Photo: UNSW



CASE STUDY

CASE STUDY

Rewriting bone surgery

Customised implants designed to replace diseased and damaged bones are on the horizon thanks to researchers at the ARC Centre of Excellence for Electromaterials Science, based at the University of Wollongong. The researchers have developed a revolutionary hand-held device called the 'BioPen', which combines the principles of 3D printing with stem cells.

This world-first device, designed and fabricated using the Australian National Fabrication Facility, delivers cell material inside a biopolymer that is protected by a second, outer layer of gel material. The two gels are combined in the BioPen's nozzle as it is extruded onto the bone surface, and the surgeon 'draws' with the gel to fill in the damaged bone section. An ultraviolet light attached to the BioPen cures and solidifies each layer of gel as it is applied, eventually building a three-dimensional framework. Once the cells are delivered, they multiply and differentiate into nerve, muscle or bone cells and grow into functioning tissue to repair the damaged site.

The BioPen offers considerable advantages over current processes: surgeons not only have more control over where to place the cell-loaded material; they can also create customised implants while they work, meaning patients spend less time in surgery and recovery.

Photo: University of Wollongong

CASE STUDY

Environment

The RV Investigator.
Photo: CSIRO

Australia's extraordinary environment provides unrivalled opportunities for researchers.

We have the third-largest ocean territory on the planet, extending from the tropics through subtropical waters to the Antarctic continent. The land's biodiversity is equally impressive: more than 80 per cent of our flowering plants, mammals, reptiles and amphibians are found nowhere else on Earth.

Our environmental scientists are internationally renowned, marine research, from coral reefs to Antarctic sea ice systems, being an area of particular expertise. We have national strengths in ecology, evolutionary biology and plant biology as well as niche capabilities in areas such as ecological applications, soil sciences and environmental science and management. Our researchers are working across disciplines to design sustainable urban environments and conserve our natural heritage.

University research in Australia plays a vital role in helping decision makers in industry and government. From the coast to the inland, oceans to freshwater, the atmosphere to soils, our research is delivering solutions to the environmental challenges the world faces. Australian experts are well-regarded members of a range of international advisory bodies, linking Australia to the leading science and policy forums in the world.

Australia's marine research capability has been greatly boosted by the introduction of a new research vessel, RV Investigator. Our environmental observation and data-generation infrastructure is among the world's best, and we have pioneered new techniques of data integration that allow data to be brought together from diverse domains to improve our understanding of the natural and built environments. Major international projects rely on data from Australia's marine, atmospheric and terrestrial observation systems, and we are acknowledged leaders in the delivery of open-access data to researchers.

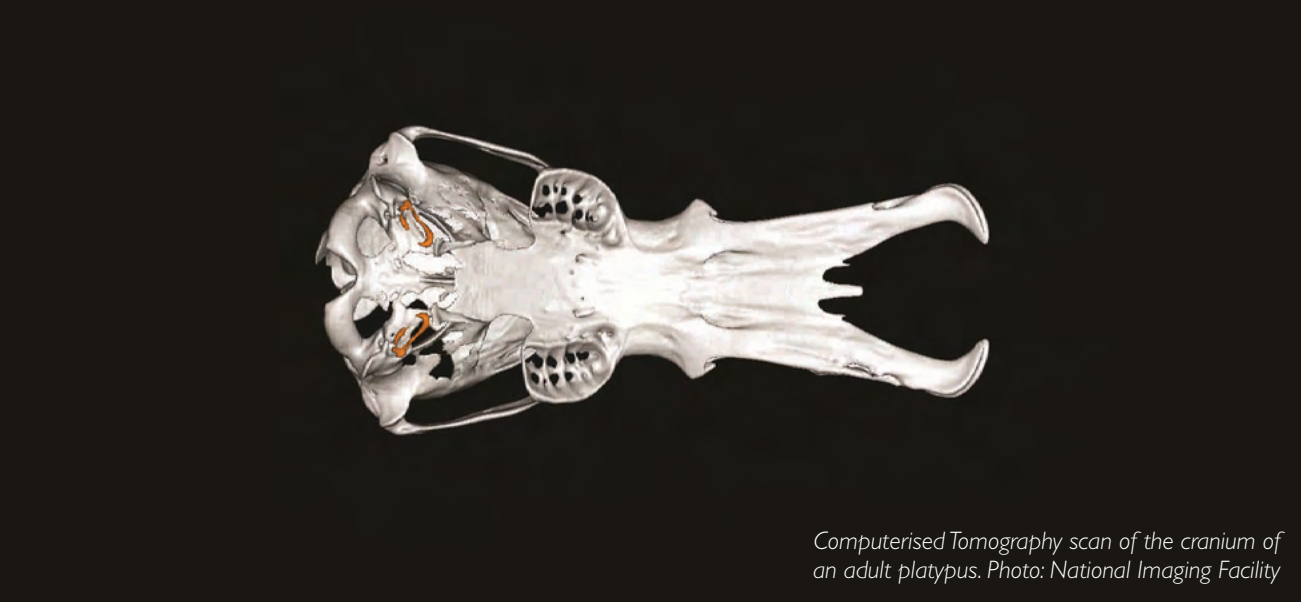
Australian Transect Network field staff in the Gammon Ranges, South Australia. Photo: Emrys Leitch

Sustainable natural and urban environments

The GeneCology Research Centre at the University of the Sunshine Coast is an interdisciplinary centre operating in genetics, ecology and physiology, in both plant and animal systems and in terrestrial and aquatic environments. Research is delivering discoveries relating to the virulence of disease agents, propagation of rare and endangered plant species, and the application of advanced genetics to marine protein sources, cellular science and biodiscovery. For example, the centre is currently working on the manipulation of hormones in order to change the sex of crustaceans, which could help boost seafood production, as well as developing a chlamydia vaccine for livestock and koalas that will improve both farm productivity and native species conservation.

Researchers at the University of Technology Sydney are investigating processes and technologies to improve the way we manage and preserve the planet's favourite water source—groundwater. The research project uses an early warning alarm system attached to trees that gives an alert when excessive groundwater is being extracted. Over three years, the project will protect 20 of the most vulnerable vegetated sites in Australia from excessive groundwater pumping. It will maintain food security and biodiversity, prevent soil erosion and protect areas with a high tourism value and cultural significance. Scientists conservatively estimate that investing in these early warning systems and protecting these ecosystems will contribute $90 million to the Australian economy alone and could potentially impact 25 per cent of the world's population, or 1.8 billion people.

Development of northern Australia is the focus of considerable attention in both research and policy terms. Charles Darwin and James Cook Universities are spearheading research affecting current and future planning for this diverse, sparsely populated region. One of the main impediments to development is the variable and dynamic nature of northern Australia's tropical, subtropical and arid environments. Research infrastructure, such as the Terrestrial Ecosystem Research Network, is providing vital information that is improving our understanding of how northern Australia's ecosystems function. Using this information, Australia's universities are helping local communities diversify



Computerised Tomography scan of the cranium of an adult platypus. Photo: National Imaging Facility

and strengthen their economic activity while protecting their unique environment.

Researchers from the Institute for Land, Water and Society at Charles Sturt University are not only improving social and environmental sustainability in Australia's rural and regional areas: they are also working to improve livelihoods and environmental outcomes in developing countries. The institute's researchers work in the fields of eco-agriculture, communication, education, regional development, cultural heritage, tourism, modelling and the arts to guide environmental policy and decision making. One of the institute's particular strengths is its expertise in water quality and delivery and, through partnerships with state, territory and federal governments as well as local land services organisations, researchers are delivering water interventions designed to save some of Australia's threatened species from extinction in catchment areas and river systems. The majority of this research is conducted in Australia's Murray–Darling Basin, but the researchers are also involved in projects in countries such as China, Austria, Italy and India.

Geoscience is an important part of environmental research and is a notable strength at Southern Cross University. In the area of geochemistry, projects are investigating biogeochemical cycles at the local, regional and global scales. The university's expertise is playing an important part in improving water quality and the management of river systems in Australia and internationally.

A national urban intelligence initiative led by the University of Melbourne and involving over 50 research institutions is helping researchers, planners and policy makers make informed decisions about Australia's cities, towns and neighbourhoods. AURIN, the Australian Urban Research Infrastructure Network, is giving researchers access to thousands of geospatial data sets from multiple sources to answer the big questions of city and town planning. Factors such as electricity and water supply, placement of new urban settlements, developing economic hubs to ensure maximum employment, designing walkable neighbourhoods and the impacts on the natural environment are being investigated using cutting-edge analytical, visualisation and big data techniques.

CASE STUDY

Photo: Tom Bridge, James Cook University

Protecting the Great Barrier Reef

Beautiful and vibrant, Australia's Great Barrier Reef is one of the most complex natural ecosystems in the world. It consists of over 3,000 individual reef systems and coral cays as well as hundreds of tropical islands and is home to a unique variety of ecological communities, habitats and species. Stretching 2,300 kilometres (longer than the Great Wall of China), this World Heritage–listed icon is the only living thing visible from space.

Conserving the Great Barrier Reef is vital not only because of its natural beauty: coral reefs around the globe provide food security for over 250 million people in 130 developing nations. The ARC Centre of Excellence for Coral Reef Studies brings together researchers from more than 150 organisations in nine countries seeking to ensure the sustainable use and management of the Great Barrier Reef and other coral reefs. Research at the centre covers areas from fisheries management to palaeontology and the impact of humans on reefs.

The centre is hosted by James Cook University, the most cited institution in the world when it comes to coral reef studies. The Australian Institute of Marine Science, the Australian National University, the Great Barrier Reef Marine Park Authority, and the Universities of Queensland and Western Australia are also partners in the centre, which has access to the SeaSim in Townsville, where researchers can manipulate environmental factors to study impacts on tropical marine organisms.

CASE STUDY

Feral pigs fighting. Photo: Thomas Garrett, Invasive Animals CRC

Protecting Australia's agriculture and biodiversity

Feral animals pose a serious threat to Australia's landscape, livestock, native animals and food security. Rabbits, carp, wild dogs, foxes and feral pigs are just some of the species wreaking havoc across the country, costing billions of dollars in reduced agricultural productivity and potentially resulting in the extinction of many iconic native flora and fauna.

The Invasive Animals Cooperative Research Centre brings together a broad range of researchers from industry, universities and government to improve pest management techniques. The Universities of Canberra, Newcastle, Queensland, Adelaide and New England are participants in the centre. Researchers are working to reduce the impact of invasive animals through developing new and humane technologies and smarter tools for integrated management.

One of the centre's many projects is mobilising community members, asking them to record and map invasive animals in various regions using the many FeralScan apps, which can record the location of pest animals, the problems they are causing, and control actions. Through this citizen science project priority areas can be identified, helping land managers target pest animal hotspots throughout Australia.

CASE STUDY

Tasmania, gateway to Antarctica

No place on Earth compares with Antarctica and its wild beauty. The coldest, highest and driest continent on Earth, it has an ice sheet covering 14 million square kilometres and it has a profound effect on the world's climate and ocean systems.

Tasmania has one of the world's largest concentrations of marine and Antarctic researchers, and is home to the Antarctic Gateway Partnership and a variety of collaborative research institutions. The Institute for Marine and Antarctic Studies, at the University of Tasmania, brings together the physical and biological sciences with the social sciences and humanities to advance our understanding of temperate marine, Southern Ocean and Antarctic environments. It works in close partnership with CSIRO and the Australian Antarctic Division. Examples of research focus are the sustainable harvest of wild marine resources, managing marine biodiversity, and investigating the Antarctic cryosphere and its interactions with the Southern Ocean.

The Antarctic Climate and Ecosystems Cooperative Research Centre has decades of expertise and a strong record of placing relevant and timely information in the hands of governments, industry and the community. The centre is working at the forefront of some of the most crucial environmental, legal and economic concerns facing the planet, and its scientists are recognised as international experts in their fields.

The University of Tasmania also leads the world-renowned multi-institutional, multidisciplinary Integrated Marine Observing System, which operates observation equipment throughout Australia's coastal and open oceans and makes all its data available to the Australian marine and climate science community and its international collaborators. Among the innovative approaches IMOS has taken is tagging elephant and Weddell seals in order to better understand circulation in the Southern Ocean. IMOS data form the foundation of new ocean-related science and enable research at finer spatial and temporal scales, improving our understanding of how global effects translate into local influences.

A tagged Weddell seal. Photo: Clive McMahon, Sydney Institute of Marine Science

CASE STUDY

CASE STUDY

Atmospheric time machines

From above it looks like six Stonehenge circles each 25 metres across; from the ground, the view suggests unfinished high-rise buildings (nine stories high) complete with half a dozen 43-metre cranes. These strange, monolithic rings in woodland near the Western Sydney University are in fact atmospheric time machines.

The university's Hawkesbury Institute for the Environment has embarked on the Eucalyptus Free Air CO2 Enrichment, or EucFACE, experiment, the world's first forest-scale carbon dioxide enrichment project in natural forest. Having taken more than five years of planning and two years to build, this complex climate change experiment is exposing tracts of woodland to elevated concentrations of atmospheric carbon dioxide, similar to those predicted for the next 35 years.

EucFACE consists of six carbon-fibre rings, three that act as controls and three that release carbon dioxide into circular plots 25 metres in diameter. The impact of the higher carbon dioxide levels on everything inside the rings—from the genes in plants, insects and microorganisms to the growth rates of trees—is being studied by researchers from a range of Australian and international universities. The project aims to redress a major gap in our understanding—how our unique, eucalypt-dominated ecosystems will react to higher concentrations of carbon dioxide.

Photo: Western Sydney University

CASE STUDY

Resources and energy

Australia is endowed with an abundance of mineral resources—including the world's largest reserves of lead, nickel, uranium and zinc. Mining accounts for nearly 10 per cent of gross domestic product and employs more than 250,000 people.

The nation's success in mining, exploration and efficient energy has been based on years of world-leading research and development. Universities in Australia are responsible for many of the innovations and advances being adopted by resource and energy industries globally.

Australian universities are bridging the gap between cutting-edge research and the changing needs of the mining industry worldwide. Research focuses on developing new and modified mining methods and processes and state-of-the-art mining equipment, as well as ensuring the safety of employees and the community. Research into sustainable mining practices is also an area in which Australia leads the way.

The world's prosperity relies on secure, affordable and sustainable energy that is delivered through a mix of sources and technologies. Researchers in Australia are experts in solar, wind, geothermal, clean-coal and ocean-power energy generation and are spearheading new battery, biofuel and fuel-cell technologies. The aim is to create intelligent grids that connect and integrate all kinds of energy sources.

Australian universities excel in fundamental and applied research to support large-scale reduction of greenhouse gas and other emissions. We are producing novel energy solutions for process industries and the power generation and electricity distribution industries at both the domestic and the international levels.

Resources and energy research is well supported in Australia through infrastructure ranging from laboratory-scale equipment to pre-pilot facilities capable of scaling-up processes and larger demonstration and prototype facilities. Access to information about the mineralogy and composition of our continent has been instrumental in geology being recognised as an area of national strength.

Photo: University of Western Australia

Photo: AuScope

Mining, exploration and efficient energy

Researchers at the University of Western Australia and Curtin University are benefiting from their location close to Australia's mining heartland to perform high-impact research, bolstering Australia's economic powerhouse. Mining research is one of Curtin's core capabilities, and the university partners with some of the world's largest resource companies, such as Chevron, Woodside, Shell, BHP Billiton and Rio Tinto. Curtin's expertise extends beyond the hard science of mineral exploration: researchers are also investigating areas associated with the social license to operate—an increasingly important aspect of resource development and operation.

The University of Western Australia's reputation as a world leader in resources research is founded on a depth and breadth of expertise in a wide range of disciplines. As just one example, researchers are creating 3D mineral maps using integrated surface and subsurface sensing data. This work provides the mineral-mapping capabilities that better equip the industry for the challenges of sustainable exploration and mining.

CRCMining is a collaboration between industry giants and Australia's top universities in mining research—the Universities of Western Australia, Queensland and Newcastle and Curtin University. The organisation is responsible for developing many breakthrough technologies being used on mine sites around the world, from payload-measuring to collision-detection systems to first-generation drill automation. Employee safety has been improved as a result of innovations such as the SmartCap, a baseball cap that continually monitors the wearer's brainwaves to determine their level of fatigue-induced impairment.

The vast area taken up by windows on buildings could soon become a source of electricity, using technology that turns them into transparent solar panels. ClearVue glass, being developed commercially using research from Edith Cowan University, is an intelligent glass technology that converts the ultraviolet and infrared components of sunlight into electricity while allowing visible light to pass through. This new product was made possible through the university's expertise in integrating microelectronics and photonics.

The Reflux Classifier
Photo: FLSmidth

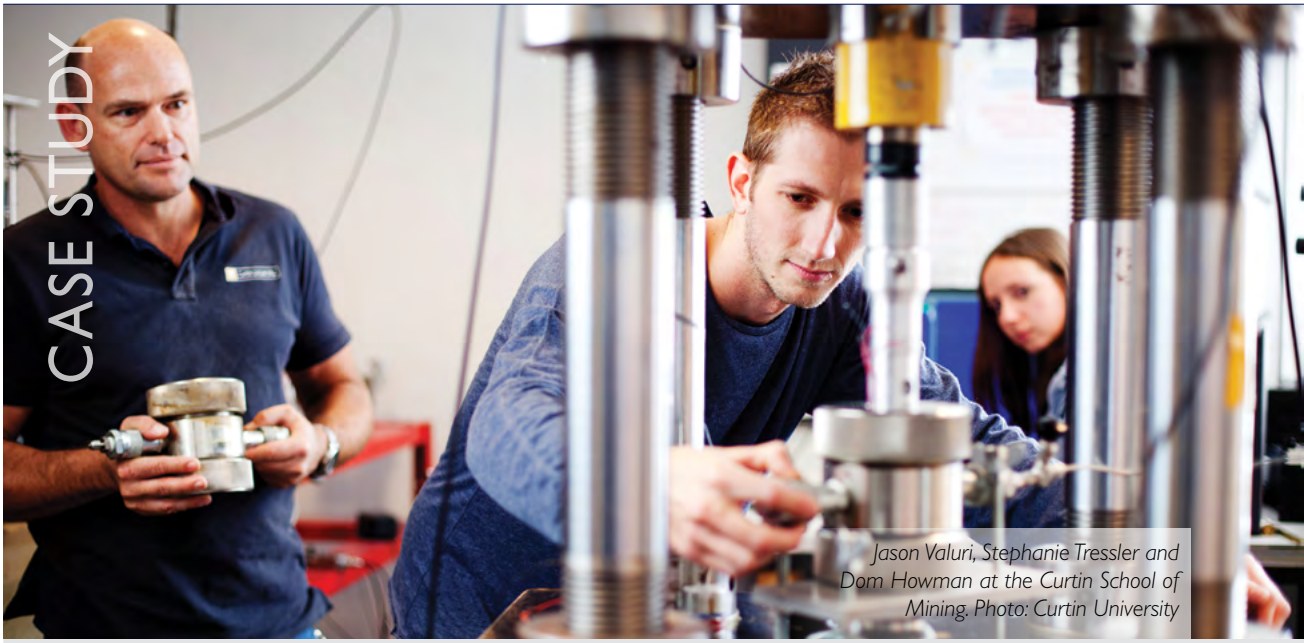
The first commercial trials of the product are taking place in South Africa, where ClearVue glass is being installed in a government office building in Pretoria.

Large-scale test bed and pilot plant operations at the University of Newcastle are a central part of the university's success in energy and resources research. Researchers are responding to the challenges of rapidly emerging issues of resource sustainability, productivity and competitiveness associated with energy and resources infrastructure. For example, the Reflux Classifier is an award-winning industrial machine that separates fine particles on the basis of either density or size; this technology solves previously intractable industrial problems and saves millions of dollars in the global mining and minerals processing industry.

The biorefinery industry is considered an important growth sector for the world, and researchers at QUT are positioning Australia as a leader in the sector. They are pioneering new technologies to convert crop waste into high-value bioproducts such as transport fuel and greener replacements for plastics, resins and chemicals. An important advantage is the university's unique pilot-scale research and development infrastructure.

Researchers at the University of New South Wales recently set a world record in solar energy efficiency, converting over 40 per cent of the sunlight hitting a solar system into electricity. This milestone is the latest in a long line of achievements by UNSW solar researchers spanning four decades. Among these achievements are the first photovoltaic system to convert sunlight into electricity with over 20 per cent efficiency in 1989 and world records of 23 and 24 per cent efficient solar cells in 1990 and 1994 respectively. More recently, the team has developed a solar cell processing technology that will allow lower quality silicon to outperform more expensive materials.

CASE STUDY



Jason Valuri, Stephanie Tressler and Dom Howman at the Curtin School of Mining. Photo: Curtin University

Innovation in exploration

Western Australia is a global centre of technical innovation for the mining and exploration industry. It is home to the largest group in the world focused on innovative research and development in mineral exploration and resource management. The Centre for Exploration Targeting is a unique applied research enterprise working on cost-effective, high-quality mineral exploration. The centre is a collaboration between the mineral exploration industry, the University of Western Australia, Curtin University and the Government of Western Australia. A diverse membership base of over 60 national and international companies integrates with the centre, providing a gateway to mining and minerals opportunities worldwide for students and early career researchers.

The centre is an attractive destination for international researchers and students: more than 30 international doctoral students are scholarship recipients, and the centre hosts international staff performing research into mineral systems on every continent. It is delivering research results that are increasing both the rate and the quality of discoveries made in mineral exploration, without substantial increases in exploration expenditure.

CASE STUDY

Lochiel Park, South Australia.
Photo: University of South Australia

Low carbon living

The Low Carbon Living Cooperative Research Centre is blending social sciences and technology research by creating buildings and precincts of sustainability and low carbon living. Three 'living laboratories', in South Australia, are putting integrated energy, water, waste and transport solutions under the microscope.

The centre is taking advantage of the transdisciplinary expertise of its researchers to examine how communities live and interact with new energy and sustainability technologies. The researchers are measuring the social factors associated with how a sustainable precinct works, including the value proposition for residents, the choices they make and the behaviours they demonstrate. This research is providing the tools for reducing the carbon footprint of urban systems.

The Low Carbon Living CRC is a partnership between industry, government organisations, the Universities of New South Wales, South Australia and Melbourne, Swinburne University of Technology, Curtin University and CSIRO.

CASE STUDY

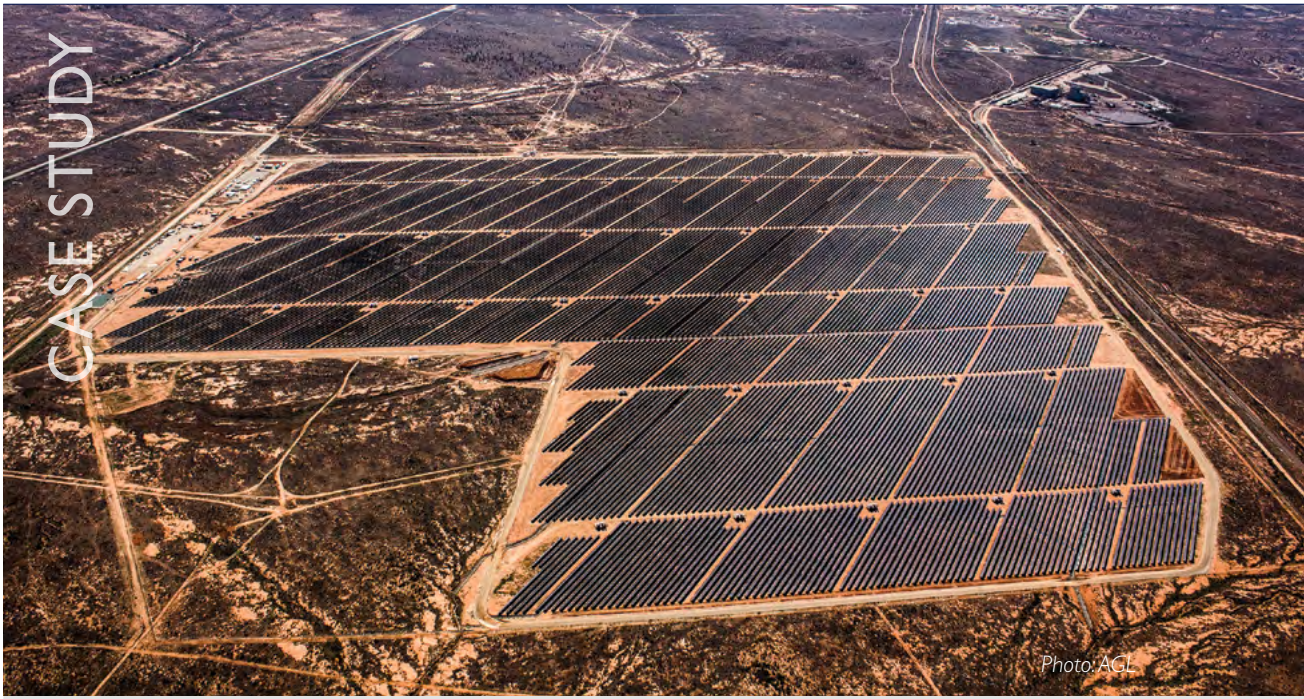


Photo: AGL

Australia's largest solar power plant

The University of Queensland is the lead researcher for a $450 million solar farm project being built in western New South Wales. The AGL Solar Project will create Australia's largest solar power plant and the first in the Southern Hemisphere to be built at the utility scale. The aim is to increase knowledge relating to large-scale solar energy by constructing two solar photovoltaic power stations that between them will have a generation capacity of up to 155 megawatts of electricity.

The university is supporting the development and operation of the power plants by building a research plant at its Gatton campus to test tracking technologies and performance, energy storage and operational strategies. It is also building a centre to collect and analyse data from the research plant and the main power stations. Project partner the University of New South Wales will develop new energy modelling techniques to assist in the design and integration of solar power stations into the electricity grid.

CASE STUDY

Photo: Griffith University

It's 'off the grid'

Griffith University is home to Australia's first research and teaching facility relying entirely on photovoltaic arrays and hydrogen technologies to keep it off the power grid. Revolutionary in design, the Sir Samuel Griffith Centre is an example of genuine sustainable energy alternatives, showcasing the university's leadership in the practical application of environmental research. The centre is covered by 1,124 solar panels that supply energy to the building; hydrogen fuel cells constitute a second power source in the event of a rainy day. At night, stored energy is used to chill water for the main air-conditioning system to run the next day.

The concept for the centre derives in part from the principal node of the National Hydrogen Materials Reference Facility, which has its headquarters at Griffith University. The facility is a state-of-the-art laboratory that focuses on hydrogen storage materials, and its researchers have expertise in materials development, microelectronics and microfluidics. Research projects span the disciplines of physics, chemistry, biology, applied mathematics and engineering.

The University of Adelaide is one of Australia's Group of Eight research-intensive universities. Researchers at the university are seeking to address some of the greatest global challenges in areas such as sustainable energy, disease prevention, paediatric and reproductive health, climate change adaptation and mitigation, maintenance of biodiversity, and agriculture and food security. The 2015 ERA results confirmed the high quality of the university's endeavours, with 82 per cent of its research subfields achieving a rating of above or well above world standard. Adelaide is also one of the highest ranked universities for commercialisation and industry contract income in the country, with hundreds of applied research engagements with external partners. The university also leads or is an active participant in many government-funded Centres of Excellence and Cooperative Research Centres and attracts among the highest levels of Rural Research and Development Corporation funding in Australia.

http://www.adelaide.edu.au/

The **Australian Catholic University** has seven research institutes, all established in 2014. The Mary MacKillop Institute for Health Research, the Institute for Health and Ageing and the Institute for Positive Psychology and Education concentrate mainly on health, especially nursing, human movement and sports science, psychology, public health, ageing, positive psychology and wellbeing. The Institute for Religion and Critical Inquiry, the Institute for Religion, Politics and Society and the Institute for Social Justice focus on religion and religious studies, philosophy and social justice (including political science and ethics). Research in theology is complemented by research into the politics, history, sociology and philosophy of religion. The Learning Sciences Institute Australia concentrates on improving the learning outcomes, wellbeing and life chances of children and young people, especially those experiencing disadvantage, on the margins or at risk.

http://research.acu.edu.au/

Scholars at **The Australian National University** lead global thinking on issues of national and international significance and students go on to become leaders in their home countries and on the world stage. Founded by the Australian Government in 1946 to apply the best minds to the biggest questions and advance Australia's international standing, ANU has grown to become one of the world's foremost research-intensive centres of higher learning. It is consistently ranked in the top 100 universities in the world by a range of international measures, and 90 per cent of research from its scholars is rated above world standard or well above world standard by the Australian Government's ERA initiative. ANU is recognised as a leading contributor to public policy formulation and debate. The university's location in the nation's capital, alongside the Australian Government and national cultural and scientific bodies, and its focus on national policy make it a unique resource and partner for government and the parliament.

www.anu.edu.au/research

At **Bond University** centres of research excellence are clustered around evidence-based health care, exercise and sport science, business and law. The university's research profile has grown rapidly since 2008 and now includes a $14 million Collaborative Research Network project and numerous Australian Research Council and National Health and Medical Research Council fellowships and program grants. In the next five years the university plans to increase its research work in priority areas where it will have an impact on the national and international communities and will continue to 'punch above its weight' as a research institution. The aim is to build the research workforce, double the number of higher degree by research students and produce graduate researchers who are well prepared for diverse careers as research and innovation leaders.
http://bond.edu.au/researchers

The **University of Canberra** is a creative and innovative tertiary institution, with a bold vision and a commitment to make significant breakthroughs in research. Ranked by both the Times Higher Education and QS World University Rankings in the top 4 per cent of universities globally, and listed among the top 100 universities under the age of 50 by QS in 2015, the University of Canberra carries out valuable research to solve real-world problems. Its areas of focus—environment, governance, communication, education and health—are supported within four university research centres and several faculty-based research centres. Its research culture is based upon a dynamic and collaborative environment, producing high-quality and high-impact work that makes an early and significant difference to the world. A strong research focus and the development of strategic national and international partnerships, as well as commercial opportunities, underpin its achievements and are key to its future impact in research.
http://www.canberra.edu.au/research

CQUniversity is a multi-campus university having its roots in northern regional Australia. Its research agenda is driven by this power of place since it is through generating research-based knowledge and solutions that CQUniversity plays a central role in the development of regional Australia. The university's research strengths are well aligned with Australia's national research priorities, spanning agriculture and food security, environmental sciences, engineering, advanced technologies, health, economics, education, psychology and cultural studies. Being a comprehensive and fully engaged university, its research agenda also aims to enhance post-secondary teaching and learning practices, and the university sees partnerships with its regional communities, industries and government as a vital part of this.
http://www.cqu.edu.au/research

Charles Darwin University is a research-intensive university headquartered in Darwin. Its primary interests are northern Australia and Asia, and its research is recognised internationally. The Times Higher Education ranking places the university in the top 50 universities in the world under 50 years old, and the Australian Government ranks it at or above world standard in 75 per cent of its research disciplines, among them medical and health, environmental, biological, information and computing and agricultural and veterinary sciences. Given its research expertise in northern Australia and its presence in 20 Asia–Pacific countries, Charles Darwin University will play an important role in promoting the social and economic development of the region.
http://www.cdu.edu.au/research

Charles Sturt University is a multi-campus, regional university in NSW with recognised internationally competitive research strengths in agricultural science, horticultural production, food and wine sciences, crop and pasture production, veterinary science, animal production, education, curriculum and pedagogy, environmental science, applied ethics, philosophy, religious studies, criminology, nursing and marketing. The university's researchers work in consultation and collaboration with end-users, industry, the professions and communities for the public good. CSU has a proud tradition of delivering high-quality research that creates new knowledge, benefits people's lives, enhances the profitability of regional industries and helps communities grow and flourish. Through its higher degree by research programs, CSU is training the next generation of researchers and professionals who use critical thinking and seek to influence the world for the better. CSU has campuses in Albury-Wodonga, Bathurst, Canberra, Dubbo, Goulburn, Manly, Orange, Parramatta, Port Macquarie, Wagga and Wangaratta.
http://www.csu.edu.au/research-csu

Curtin University focuses its resources on investing in areas of high-quality research and creative production that have relevant and significant impacts on communities. The multidisciplinary and collaborative nature of the university's research programs is made possible by solid research partnerships with industry, the presence of leading research staff, and the diversity of research centres and institutes. Curtin's primary areas of research are closely interwoven and accessible across the university's four academic faculties—Curtin Business School, Science and Engineering, Health Sciences, and Humanities. Through targeted research, Curtin aims to influence public debate and policy on issues that matter to society.
http://www.research.curtin.edu.au

Research is a cornerstone of activity at **Deakin University.** A significant investment over the past five years has begun to yield results in terms of the quality of research outputs, reputation and research culture. There has been an explosion in the number of research-intensive staff and teaching-and-research academic positions. This rapid growth, coupled with high aspirations, has led to a new phase of planning to sustain and build on the gains. Using its industry, government and institutional networks, Deakin is striving to build on its global research footprint across four key themes: Improving Health and Wellbeing; Designing Smarter Technologies; Enabling a Sustainable World: and Advancing Society and Culture. The objective is to make a difference, through world-class innovation, to the communities the university serves, be they local, national or global.

http://www.deakin.edu.au/research/

Edith Cowan University conducts world-class research that focuses on people, partnerships and results. Within the university, research institutes of international standing are dedicated to benefiting communities in the areas of digital forensics and security, exercise as medicine, education and electron science. A collaborative and supportive environment encourages research excellence through partnerships and engagement. This approach has been internationally recognised: in 2015 Edith Cowan University was named in the Times Higher Education 100 Under 50 Rankings, and in the QS World University Rankings by Subject it was named in the top 200 for communications and media studies and education and training. The QS rankings, which are based on reputation and research citations, demonstrate that the university continues to be a world leader in these subject areas.

http://www.ecu.edu.au/research/overview

In partnership with industries, governments and research institutes, **Federation University Australia** engages in a wide range of applied research designed to benefit the communities the university serves. This approach has led to a world-first real-time visualisation of integrated land and water resources; a new carbon capture laboratory to assist Australia's energy industries in their transition to a low-carbon economy; and the hosting of the only Australian injury research and prevention centre endorsed and funded by the International Olympic Committee. The biomedical research team is part of a worldwide quest to find genes and new treatments for high blood pressure, and the university's work with the Fiona Elsey Cancer Research Institute supports research into the role of immune cells in cancer. Additionally, the university demonstrates growth and success in developing innovative multimedia concepts, artificial intelligence and image processing, as well as a long history of mathematics and optimisation research.

http://federation.edu.au/research

Flinders University has a vibrant and constantly evolving research community that operates within a range of disciplines broadly housed under five research themes, each containing a number of research clusters, institutes and centres. The Biomedical and Clinical Sciences theme includes ophthalmology, pharmacology and cardiovascular medicine and is home to the Flinders Centre for Innovation in Cancer. The university also has a strong tradition in Culture and Society research, its particular strengths being in law, creative writing, criminology, archaeology and sociology. Health and Human Behaviour provides new perspectives in areas such as obesity prevention, forensic psychology, and cancer treatment and prevention. Molecular Science and Technology encompasses everything from plant biology to clean technology while working with industry partners on projects such as desalination refinement. Finally, the university has a strong Water and Environment theme that takes in groundwater, ecology and water recycling.
http://www.flinders.edu.au/research/

Griffith University was established over 40 years ago with a focus on the Asian region as one of its founding principles. The university's research and partnerships are strongly linked to Asia to address critical issues in the region, such as politics, security and development, drug discovery and infectious diseases, water and environmental sciences, climate change adaptation, and sustainable tourism. The newly established Menzies Health Institute Queensland at the university's Gold Coast campus is ideally co-located with Gold Coast University Hospital to address critical health issues both for south-east Queensland and the Asian region. The university has also had a long history of research excellence in the social sciences and humanities, focusing on criminology and crime prevention, education, and music, the arts and the Asia–Pacific region. Griffith has also invested substantial resources into expansion in the natural and physical sciences, especially in areas such as engineering and IT.
http://www.griffith.edu.au/research/research-excellence

James Cook University has an explicit focus on research into the critical challenges facing natural and human systems in the tropics, worldwide. It has internationally recognised research strengths in environmental science and management, coral reef science, ecology, biology and biochemistry, plant and animal science, earth sciences, tropical health and medicine, medical microbiology, high-speed wind engineering, Indigenous knowledge, archaeology and linguistics. JCU initiated the State of the Tropics project—a partnership of twelve leading research institutions from around the world—with a focus on environmental, social and economic issues relating to the tropics. One of the university's defining features is its tropical location: the Australian campuses are adjacent to two UNESCO World Heritage areas—the Great Barrier Reef Marine Park and the Wet Tropics rainforests of northern Queensland.
http://www.jcu.edu.au/research/

La Trobe University encourages innovation, specialisation and collaboration and has a history of excellence and an enduring social conscience. Among the current research focus areas are Building Healthy Communities (equity, wellbeing and social inclusion); Securing Food, Water and the Environment (solutions for global challenges); Sport, Exercise and Rehabilitation (health and better performance); Transforming Human Societies (mobility, societies and social and cultural change); and Understanding Disease (the molecular, cellular, individual and population perspectives). The university's disciplinary excellence is also reflected in programs in English, theatre, drama, history, international development, linguistics, education, philosophy, archaeology, and physical, mathematical and computing sciences. La Trobe University's aim is to respond to crucial questions for the future of human societies and their environments.
http://www.latrobe.edu.au/research

Macquarie University is a world-recognised research collaborator, with one out of every two of its research publications being co-authored with national and international collaborators. Home to some of the world's pre-eminent researchers, the university is a hub of research excellence in a variety of disciplines. More than 120 of its researchers have produced highly cited papers ranking them as researchers in the top 1 per cent for their research field. In the past five years Macquarie has built on its outstanding reputation through specific investment in areas of national and international significance, and it continues to recruit top-class researchers for five future-shaping research priorities—Healthy People, Secure Planet, Resilient Societies, Prosperous Economies, and Innovative Technologies—with a view to producing research that has world-changing impacts. Additionally, Macquarie is the host institution of, or has a major node in, five ARC Centres of Excellence, hosts the Australian Hearing Hub, and applies its cutting-edge research in a Macquarie-owned private hospital.
http://www.mq.edu.au/research.php

The University of Melbourne enjoys an outstanding reputation, and world rankings consistently place it as Australia's leading comprehensive research-intensive university. The university attracts and cultivates the best and brightest researchers from around the world. It collaborates with industry, other institutions and research organisations, the community, government and not-for-profit organisations to achieve research outcomes with global impacts. It has 10 discipline-specific faculties, five institutional interdisciplinary institutes and is affiliated with many independent research institutes, teaching hospitals and other institutions. The university has many specialist research centres and is a key collaborator or partner in numerous national centres, including Cooperative Research Centres, ARC Centres of Excellence and NHMRC Centres of Research Excellence.
http://www.unimelb.edu.au/research/

Monash University is a comprehensive, research-intensive university ranked among the top 1 per cent of universities in the world. As Australia's largest and most international university, it has five Australian campuses that are complemented by a strong presence in Malaysia, India, China, Italy and South Africa and a depth alliance with Warwick University in the United Kingdom. Its numerous research achievements in recent times have seen it recognised as the lead institution in some of the most prestigious grant schemes in Australia, with ARC Centres of Excellence (in bio-nano science and technology, advanced molecular imaging and technology, and integrative brain function), Cooperative Research Centres (in urban water management and alertness, safety and productivity), and Industrial Transformation Research Hubs (in high-value additive manufacturing, bioprocessing advanced manufacturing, and computational particle technology). The university's research excellence is underpinned by outstanding research infrastructure: in the past decade more than $500 million has been invested in facilities in regenerative medicine, electron microscopy, biomedical imaging, nanofabrication, eResearch, visualisation, advanced manufacturing and green chemistry.
http://www.monash.edu/research

Murdoch University has a long and proud tradition of delivering quality research expertise across multi-disciplinary areas. Translational in nature, its research activities are inspired by local, industry-based partnerships and large-scale international collaborations to address the unique challenges of our time. Murdoch University is now a regional centre for investigation into the crucial areas of food security, sustainable development and health futures. Its academics are world leaders and produce high-quality, international research in select fields that challenge global social and scientific needs. Research themes include animal and human health and welfare; climate variation, environmental and natural resources; and primary food production; all supported by broad contributions from researchers in arts, humanities and social science. These themes enable the translation of basic science into public policy, education, food security, water security and biosecurity, energy renewables, politics and governance in the Indo-Pacific region. Murdoch University is helping to change the world.
http://www.murdoch.edu.au/Research-capabilities/

The **University of New England** is dedicated to identifying and delivering innovations of value to society and industry in Australia and internationally, with a particular emphasis on inter-disciplinary research for tackling complex problems in rural and regional Australia. This research involves extensive engagement in large-scale collaborations within the university, nationally and internationally, and is underpinned by thematic research priorities such as food and water security, climate change and environmental sustainability, health and wellbeing in rural communities, Australia's regional history and regional identity, and regional and rural development in countries of the Asia–Pacific region. For more than four decades the university has provided international leadership in livestock genetics through centres such as the Animal Genetics and Breeding Unit, currently celebrating its 40 year anniversary, and the Agricultural Business Research Institute and also hosts the Sheep and the Poultry Cooperative Research Centres.
http://www.une.edu.au/research

The **University of New South Wales, Australia** aspires to be Australia's global university, improving and transforming lives through excellence in research and education and a commitment to advancing a just society. Ranked in the world's top 100 universities, UNSW is a founding member of the Group of Eight and the prestigious Universitas 21 international network. It is the only Australian member of the Global Alliance of Technological Universities and is also a member of the Association of Pacific Rim Universities and a partner in the PLuS Alliance. UNSW is a leader in innovation, focusing on areas critical to the future—from quantum computing, climate change, renewable energy and sustainable cities to business, public health and human rights. UNSW's graduates are highly sought after by employers. The university has strong ties with industry and leads the country in ARC Linkage grants, numbers of student start-up programs, technology millionaires and top CEOs. Through its bold 2025 strategy, its focus for the future is on the three priorities of academic excellence, social engagement and global impact.
http://research.unsw.edu.au/

The University of Newcastle harnesses the capacity of its world-class researchers to foster innovation and deliver impact in its region and across the world. The university's global reputation is built on areas of disciplinary strength including science and engineering, health and medicine, and energy and resources, and is a leader in Indigenous engagement in education and research. Fields of emerging excellence include applied mathematics, social work, creative industries, earth sciences and nutrition and dietetics. Championed by two flagship research institutes, the Newcastle Institute for Energy and Resources and the Hunter Medical Research Institute, the university drives engagement and collaboration in partnership with industry, business and government to deliver cross-disciplinary research translated into word-class innovation. The university is currently ranked in the top 3 per cent of universities globally by both the Times Higher Education and QS world rankings and UON was ranked in the top 8 of Australian universities for research rated at 'well above world standard' in the latest ERA assessment.
http://www.newcastle.edu.au/research-and-innovation

The University of Notre Dame Australia has campuses in Western Australia and New South Wales and clinical schools in New South Wales and Victoria. Research initiatives are predominantly community driven, with the underlying purpose of turning evidence into action. A variety of research is supported, strengthening senior research capability and mentoring early career researchers in many disciplines. Particular effort is directed towards the areas of health (including medicine, nursing, health sciences, physiotherapy and health education), Indigenous research, education, philosophy, theology and ethics. Three research centres support this research—the Nulungu Research Institute, the Institute for Health Research and the Institute for Ethics and Society. **http://www.nd.edu.au/**

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

The University of Queensland, ranks in the world's top 50 universities as measured by the QS World University Rankings and the Performance Ranking of Scientific Papers for World Universities. UQ's research community excels, partnering with global research institutions, industry partners, and government and non-government organisations in 48 countries to achieve important outcomes in research fields of national and international significance. The 2015 ERA reaffirmed UQ's exceptional quality of research, with 100 per cent rated at world standard or above, and 95 per cent rated above or well above world standard. With many notable discoveries to its credit, UQ is a leading source of expertise in many strategically important areas of research. By pursuing excellence in discovery, learning and engagement, UQ is committed to transforming our successes into far-reaching benefits for people globally.
http://www.uq.edu.au/research/

QUT Queensland University of Technology

QUT is a major Australian university that ambitiously positions itself as a university for the real world of today and tomorrow. It engages in high-impact research in selected areas to achieve public, commercial and practical benefits for the community and for its partners. The main research areas are biomedical engineering and health technologies; biomolecular science; chronic disease intervention; data science, computational modelling and simulation science; digital media; educating and engaging children and youth; health systems; injury prevention and management; innovation; materials science and engineering; plant biotechnology; robotics and computer vision. QUT is backing its aspirations with significant and continuing investment in people and high-quality support and facilities for its researchers. It has invested more than half a billion dollars in state-of-the-art infrastructure and collaborative work environments in the past six years.
http://www.qut.edu.au/research

RMIT UNIVERSITY

As a global university of technology, design and enterprise, **RMIT University** works with its partners to create innovative solutions that will transform the future. Through a focus on application and transformation, research is undertaken in specialised areas of strength that underpin the curriculum. Among these specialised areas are advanced manufacturing and fabrication, advanced materials, biomedical and health innovation, design and creative practice, global business innovation, information and systems engineering, social change, and urban futures. These clusters of research excellence are being deployed to deliver significant economic, societal and environmental benefits. By connecting its areas of research excellence and using that excellence to respond to crucial local, national, regional and global challenges, RMIT is making a difference. This is borne out by the 2015 QS rankings, in which RMIT was placed in the top 100 universities in seven disciplines—architecture, art and design, and five engineering and technology areas. **http://www.rmit.edu.au/research**

University of South Australia

At the **University of South Australia**, research is inspired by challenges and opportunities, partnered with end-users and communities, and underpinned by excellence. The spirit of enterprise defines research at UniSA. The research culture is vibrant, outward-facing and responsive. The university engages meaningfully and creatively with its peers, industry and the community in ways that are aligned and responsive to state, national and international priorities. Powered by 97 per cent of research being world class or above, its thematic, transdisciplinary approach brings together a breadth of research expertise in new and innovative ways that focus on end-to-end approaches and real-world solutions. Across diverse areas, from cancer and societal and global transformations to energy and the environment and the development of future industries, the university's leading-edge research is delivering rich, robust, multi-faceted and end-user relevant outcomes.

http://www.unisa.edu.au/Research/

Southern Cross University

Southern Cross University aims to create research and research training that has global relevance and global impact. Its research is focused on creating knowledge in its areas of research strength including environmental sciences, plant sciences, geoscience, forestry, gambling research, marine science, business, education and tourism. In the 2015 ERA report the university received the highest possible rating, 'well above world standard', for geochemistry, oceanography, environmental science and management, zoology, crop and pasture production, complementary and alternative medicine, nursing and forestry sciences. A rating of 'above world standard' was gained for soil sciences, ecology, fisheries science, civil engineering, resources engineering and extractive metallurgy and human movement and sports science. A rating of 'at world standard' was gained for tourism and policy and administration.

http://scu.edu.au/research/

UNIVERSITY OF SOUTHERN QUEENSLAND AUSTRALIA

The **University of Southern Queensland** delivers internationally recognised research, innovation and practice across a broad spectrum of disciplines, from agricultural to mathematical and physical sciences. Its three campuses are located in differing geographic and socio-economic settings, providing a close and direct relationship between the university and current developments in Australia's regional communities. The university is recognised for its long-term excellence in agricultural and environmental research and emerging strengths in regional systems, digital futures, mathematical sciences and biomedical sciences. These areas of research align with national and international challenges that must be overcome if the world is to sustain its growing population.

http://www.usq.edu.au/research

The **University of the Sunshine Coast** is Australia's youngest and fastest growing university and aspires to become one of the world's top 100 young universities within five to 10 years. It is rapidly developing regionally relevant, yet nationally and internationally significant, research that focuses on six areas—aquaculture, forestry, animal and human health, environmental science and management, human factors and sociotechnical systems, and the social aspects of sustainability. Central to research development at the university is the establishment of productive partnerships with leading research institutes, universities and end-user organisations, both nationally and abroad, with an emphasis on bolstering existing areas of research strength.
http://www.usc.edu.au/connect/research-and-innovation

Swinburne University of Technology is an internationally recognised research-intensive university that is focused on delivering research that creates economic and social impact. Its researchers are producing innovative research solutions to real-world problems across a range of disciplines and sectors. In 2015, Swinburne was listed in the world's top 400 universities in the prestigious Academic Ranking of World Universities and one of the world's top 400 universities by the Times Higher Education University World Rankings 2014–2015. Swinburne is committed to delivering world-leading research outcomes and innovations in select areas of science, engineering and technology. In 2016 Swinburne will be launching a number of exciting initiatives to drive its future research achievements. Its new 'Innovation Precinct' in Hawthorn, Melbourne will be a hub of world-class research-led innovation activity, and its new Research Institutes will focus on big challenges facing industries and society. Swinburne's research future is bright.
http://www.swinburne.edu.au/research/

The University of Sydney is one of the world's leading comprehensive research and teaching universities, consistently ranked in the top 1 per cent of universities in the world. For more than 160 years it has been producing the next generation of thought leaders for the benefit of society. Its research is motivated by the 'big picture', taking a problem, looking at it from all angles and bringing together the world's most talented researchers and scholars in multidisciplinary teams. Its research strategy is framed around a distinct set of high level areas of focus, including the pressing health challenges of our time (including diabetes, obesity and cardiovascular disease), mental health and neuroscience. In creating the first university in Australia, the University of Sydney's founders recognised the power of education and research to change society. That belief is held just as strongly today. **http://sydney.edu.au/research/**

The **University of Tasmania** is the fourth oldest university in Australia established in 1890. Its campus locations allow it to engage with the Tasmanian community and utilise the best of its island's natural and built resources to deliver high quality research outcomes. The university provides international leadership in five thematic areas: Environment, Resources and Sustainability; Creativity, Culture and Society; Better Health; Marine, Antarctic and Maritime; and Data, Knowledge and Decisions. This leadership is demonstrated through its research institutes, including the Menzies Institute for Medical Research, the Institute for Marine and Antarctic Studies (IMAS), the Centre of Excellence in Ore Deposits (CODES), and the Australian Centre for Research on Separation Science (ACROSS). The university is also a leader of the ARC's Industrial Transformation Scheme, focusing on cutting-edge research for new technologies, economic and social transformation and the training of young and emerging researchers to foster end-user focused research.
http://www.utas.edu.au/research

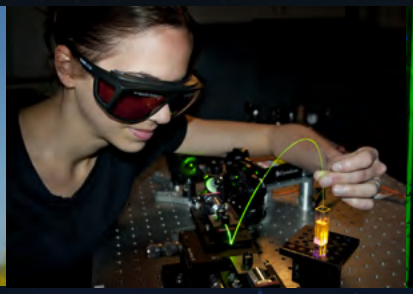
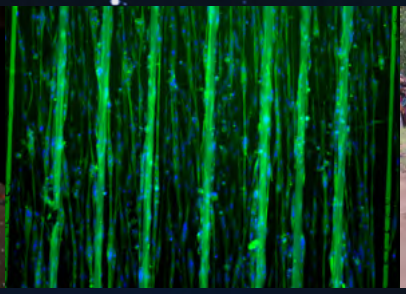
The **University of Technology Sydney** is Australia's number one young university, boasting a worldwide reputation of producing ground-breaking research, programs of innovation, commercialisation outcomes, and access to the best graduates. With over 350 partnerships in more than 40 countries, UTS is ranked 28th in the world on international outlook in the Times Higher Education 2015 rankings and has key technology partnerships with leading universities in greater China, India and Europe. Its world-leading research centres span a range of local and international expertise, among them health, data science, sustainability, social futures, and future work and industry.
http://www.uts.edu.au/research-and-teaching

At **Victoria University** research focuses on three interdisciplinary themes—sport, health and active living; education, lifelong learning and workforce development; and sustainable industries and liveable cities. The university's research strength is evident in six institutes and five centres—the Institute for Supply Chain and Logistics; the Institute of Sport, Exercise and Active Living; the Institute for Sustainability and Innovation; the Victoria Institute for Education, Diversity and Lifelong Learning; the Victoria Institute for Strategic Economic Studies; the Mitchell Institute for Health and Education Policy; the Centre for Applied Informatics; the Centre for Cultural Diversity and Wellbeing; the Centre for Environmental Safety and Risk Engineering; the Centre for Strategic Economic Studies; and the Centre for Chronic Disease Prevention and Management. The university conducts research across the spectrum, with a particular focus on applied and translational research.
http://www.vu.edu.au/research/research-focus-areas-expertise

Founded in 1911, **The University of Western Australia** is one of the world's top 100 universities. In the past century it has built up an impressive array of high-tech infrastructure, research equipment and longitudinal research data, drawing collaborators from around the world. The university aims to harness its expertise and engage with local and global partners (government, industry, other researchers and the wider community) to resolve the great 21st century challenges our planet and our species face. The university is engaged in a number of strategic research areas—plant sciences and sustainable food production; ecology, evolution and the environment; energy and minerals; Indigenous knowledge; medicine and health; and radio astronomy and data intensive science.
http://www.uwa.edu.au/

Western Sydney University undertakes research that changes lives. Research that creates meaningful change in the economy, in communities and in the environment can come only through research based on the needs of those working in our economy, living in our communities, and seeking to preserve our environment. This is the research Western Sydney University undertakes—research directed beyond the university to create impact and value for our partners. Western Sydney University is connected to Australia's largest urban region, Western Sydney. The university shares the region's diversity and size. Forty per cent of the community speak a language other than English at home. Only 26 years old and already one of the world's top 100 young universities, the university has four major campuses, 44,000 students and 3,300 staff. The university is one of Australia's largest research-led universities but takes a distinctive approach; it couples diversity and scale with flexibility, focusing its research on the needs of communities extending from Western Sydney to India, China, the United States and elsewhere.
http://www.westernsydney.edu.au/research

The **University of Wollongong** recognises that in this time of unprecedented change, universities have an obligation to lead and contribute to society. Having emerged as a benchmark for Australia's next generation of universities, UOW courses and research capacity are geared towards excellence at a global level. Ranked amongst the world's best modern universities, UOW is fostering research that crosses disciplinary boundaries, placing it at the forefront of work that is tackling global social, economic and environmental challenges. As the Australasian member of the University Global Partnership Network, the university's strong international outlook is demonstrated by partnerships with peers and industry, government, and community based organisations around the world. Committed to emergent industries and future jobs, UOW is one of a small number of universities responding to global concerns by harnessing its research strengths, establishing its place as a leader in discovery and learning and transforming the world in which we live.
http://www.uow.edu.au/research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