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ATSE

FOCUS

BLUE SKY FUTURE FOR AUSTRALIA

NOTHING IS IMPOSSIBLE – WE CAN MAKE ANYTHING HAPPEN IF WE USE OUR BEST MINDS

AUSTRALIAN ACADEMY OF
TECHNOLOGY AND ENGINEERING

ATSE

2017 ATSE NATIONAL TECHNOLOGY CHALLENGES DIALOGUE

THE CRISIS IN AGEING

Technology to manage the challenges in healthcare

The Academy's National Technology Challenges Dialogue is a one day event and will take place in Brisbane on Wednesday 14 June 2017

The Dialogue will explore the health challenges of Australia's ageing population. Entrepreneurs, decision makers, government officials, researchers, academics and business leaders will have the opportunity to exchange ideas and together explore:

- The role of technology in active ageing
- Leap-frog technologies: looking into the future of health technology
- Opportunities and challenges of the shift towards personalised healthcare
- Using technology to prepare for, adapt to, and mitigate the challenges of the evolving health sector

The 2017 Dialogue will examine if health technology can help Australia rise to the challenge of adapting to the ageing face of the Nation, in order to mitigate issues of rising and shifting healthcare costs and needs.

It will highlight ATSE's consistent commitment to leading the public discussion on Australia's future prosperity with a focus on using the best of Australian and international technologies to address our national challenges.

It also incorporates ATSE's Annual Innovation Dinner on 14 June where the Clunies Ross Awards for innovation commercialisation will be presented. These exciting awards bring together Australia's top leaders and innovators from research, industry, academia and government and provide a valuable networking opportunity at the nation's premier annual awards for innovation commercialisation.

Dialogue details and registration will be available on the ATSE website in early 2017. For information on sponsorship packages for the two events email sue.wickham@atse.org.au

SAVE THE DATE – 14 June 2017, Brisbane
www.atse.org.au/ageing

AUSTRALIAN ACADEMY OF TECHNOLOGY AND ENGINEERING

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Front cover photo: Nothing is impossible (Photo: iStock).

FOCUS

ATSE *Focus* is produced to stimulate discussion and public policy initiatives on key topics of interest to the Academy and the nation. Many articles are contributed by ATSE Fellows with expertise in these areas. Opinion articles will be considered for publication. Items between 800 and 1400 words are preferred. Please address comments, suggested topics and article for publication to editor@atse.org.au.

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Blue planet: water futures

AUSTRALIA'S BLUE-SKY FUTURE Water must be central to governments' environmental and energy agendas: water needs a seat at decision-making tables. It is, after all, the one thing we can't live without.

The world's population is currently at an all-time high of about 7.4 billion people. The United Nations estimates it could increase to more than 11 billion by the year 2100. Climate change is expected to bring more extreme weather and extreme hydrology.

Together, population growth and climate change will intensify pressure on already scarce surface water and groundwater. Work by acclaimed international water researcher Dr Yoshihidi Wada and colleagues in 2012 demonstrated that non-renewable groundwater extraction more than tripled over the period 1960 to 2000 (from 75 to 234 km^3 per year) to constitute about 20 per cent of the global gross irrigation groundwater water extractions for the year 2000.

We will need more food. We will need more energy. We will need more water.

The amount of water required to eradicate hunger is staggering. In 2007, Professor John Rockström and colleagues estimated that to eradicate hunger by 2030 water required for irrigation of crops would increase from 1800 km^3/year in 2002 to 2320 km^3/year in 2030 and approach 2525 km^3/year by 2050.

These estimates are based on current rates of crop yields per volume of water consumed. They rise dramatically when one accounts for imperfect irrigation efficiency – and could rise to as high as 6270 km^3/year in 2030 and as high as 6824 km^3/year in 2050 (assuming an average global irrigation efficiency of about 37 per cent, as suggested by Dr Sandra Postel in 1993).

Issues of water security, water quality and contamination, sanitation and water-borne diseases will continue to plague our planet. Because we will need so much of it, water will be front and centre in almost everything our society will encounter.

Even today our current, controversial and pressing problems – unconventional gas and fracking, mining, nuclear energy and radioactive waste disposal, food production, population growth, climate change to name a few – all involve water and all involve impacts on water resources.

EMERGING CHALLENGES

There will always be a need for basic science and we are doing tremendously exciting things in hydrologic science.

We study the water cycles on other planets (extraterrestrial hydrology). We are discovering new underground creatures called stygofauna – blind creatures only millimetres long that have adapted to living in aquifers that are low in carbon and oxygen by having a slow metabolism, being long-lived and having few young.

We are now even working on the role of groundwater in the destruction, restoration and protection of antiquities such as the Pyramids of Giza. Our scientific ancestors probably never anticipated such adventures in hydrological research even a decade ago.

The water-food-energy-environment nexus will only increase in significance. The Food, Energy, Environment and Water (FE2W) Network (http://www.fe2wnetwork.org/) provides excellent information, including key facts, on this matter.

Water for food or water for sanitation can no longer be considered in isolation. Resources must be managed for resilience. Professor Rockström and colleagues in 2014 suggested a shift in focus from water resource efficiency to water resilience occurs with increasing water turbulence in the Anthropocene (the Anthropocene epoch is widely defined as the Earth's most recent geologic time period, which is human-influenced or 'anthropogenic').

Future water governance will need to account for the multifunctional roles of water in land use practices. Integrated planning and management of land and water resources is critical.

To realise these aims we need to integrate our scientific and engineering knowledge with the socio-political management of people and natural resources.

We need governance and social processes to enable us to manage water, within a policy envelope that interacts and recognises the impacts on food, water, energy and environment. The old silos must go.

Water must be front and centre in

Nothing is certain but death and taxes. Or, as Defoe originally put it, "Things as certain as death and taxes, can be more firmly believed". Any prediction I make on the global future of water will inevitably be uncertain and it will certainly be wrong. But I believe thinking about the future is an important part of bringing the future into being. These are my thoughts on the future of the most precious resource on our planet.

governments' environmental and energy agendas. Water needs a seat at decision-making tables. It is, after all, the one thing we can't live without.

We face some substantial science and technical problems.

Lack of data

One of the greatest constraints for understanding, managing and predicting the state of our water resources continues to be a critical lack of data. We desperately need faster, cheaper and more accurate ways of making environmental measurements at finer spatial and temporal resolution so we can populate our predictive models – from detailed flows in rivers and ecological impacts of altered flow regimes to contaminant migration in deep underground aquifer systems riddled with all sorts of geological complexities.

I am constantly reminded of, and daunted by, Einstein's wise counsel: "Everything should be made as simple as possible, but never simpler!" and what this means for us as water professionals – especially when we do not have enough data or our models are naively simpler than they ought to be.

Spatial heterogeneity and scale

Hydrologic science cannot currently answer many important water and environmental questions. We grapple with vast variation across multiple scales. As a groundwater scientist, dealing with heterogeneity in groundwater analyses is a daily challenge.

The variations in the hydraulic properties of our groundwater systems are gargantuan – they vary by more than 10 orders of magnitude between unfractured crystalline rock and gravels. To put this in context, this variability exceeds the difference between a casual afternoon stroll in the park and the speed of light (about 8 orders of magnitude).

Given the inherent complexities and variability, what are the appropriate emergent properties as we look at larger scales? This is the crux of the biggest problems in hydrogeology. Another major issue is how to quantify and ultimately reduce uncertainty in our analyses – especially when we suspect the uncertainty is very (and perhaps unacceptably) large.

Someone once said to me, "We put man on the moon in 1969 and hydrogeologists are still saying that they cannot predict the fate of a contaminant plume". After scratching my head for a moment, and at the risk of sounding terribly arrogant, my response was that if the pathway between the Earth and the moon was anywhere near as complex and heterogeneous as that encountered in underground aquifers, we can almost be certain we would not have got to the moon either.

For my part, I often dream about how to solve the heterogeneity problem. I flirt with the idea of smart-dust nanoparticles moving underground, transmitting information to the Earth's surface as they travel the underground geologic maze – uncovering and reporting details of their movement through fractures in real time. Geophysics and remote sensing are part of mainstream hydrology already, so why not?

Of course, the nanotechnologists I have discussed this with have smiled and indulged me for a few moments before telling me that my magical nanoparticles would either need to be tied to the end of fishing line so that we could haul them back in before plugging them into the computer to download data or would need 12V batteries strapped on their backs to have enough power to transmit signals back to the Earth's surface through a deep layer of rock!

Connecting knowledge to practical implementation

While there will always be a plea for more research (and more funding!), I am acutely aware of the growing gap between research and practice and the need to use every tool in the toolbox. As American psychologist Abraham Maslow once said "I suppose it is tempting, if the only tool you have is a hammer, to treat everything as if it were a nail".

In my discipline of groundwater there are many examples of great science that have not yet made it into everyday practice – geostatistics, environmental tracers for characterising groundwater and parameter estimation methods are just a few examples. Research has developed new approaches and tools to apply to problems that practitioners in the field aren't even using yet. Why do we persist with a hammer when the job may be better suited to a modern pneumatic nail gun?

And our challenges are not only technical. Science is necessary but not sufficient for solving many societal issues. One current challenge is gaining a 'social licence' for coal seam gas production.

We need educational reform and we urgently need to introduce hydrology to students of all ages as an exciting, important, interdisciplinary field with challenges and opportunities. Curricula must reflect modern trends, including integration with ecology, as well as other vital social, economic, legal and policy frameworks. Water problems need the very brightest minds and demand sophisticated attention.

Connecting knowledge to policy development and management

Policy and management need increasingly close ties with science. And science must return the compliment. Blue-sky work will inevitably and necessarily continue but we must continually challenge ourselves to reset the balance of academically interesting and practically important research work.

The big problems in water demand rigorous and interdisciplinary science translated into wise policy and management. The need for water managers and policy-makers to deal more effectively with risks and uncertainties is becoming increasingly apparent in the face of long-term predictions, such as the impact of climate change on groundwater or the performance of a nuclear radioactive waste repository over 10,000+ years.

Uncertainty – both biophysical *and* social – is the nature of the hydrology beast. It is our 'inconvenient truth'. We can no longer afford to give policy-makers the false sense of security that we can accurately predict the future. How we quantify, manage, reduce and communicate uncertainty – and deal with it effectively in policy settings – remains a grand challenge. How do we build the bridges and keep a two-way leaning dialogue between science/engineering and policy issues?

STRATEGIC LONG-TERM POLICY AND ACTION

Chopping and changing policy perspectives is destructive. Governments continue to slash budgets for water management and research. Agencies continue to report serious de-skilling in capacity and capability to tackle urgent water and environmental issues.

We deal daily with institutional legacies and the problems agency funding issues create.

Funding is here in droughts, gone when it rains – following what Donald Wilhite (building on earlier observations of human

perception by IR Tannehill in 1947 in *Drought: Its causes and effects*) calls the "hydro-illogical cycle": drought, awareness, concern, panic, rain, apathy, drought.

There is also a mismatch between hydrological and hydrogeological time scales and much shorter political time scales. This spawns a tendency towards very short-term work that is here today and forgotten tomorrow – hydrologic 'hits and runs' – when what we desperately need is long-term, large-scale and expensive investment in longitudinal investigations and long-term data sets.

We continue to take water for granted. Without high level representation and visibility of water in decision-making circles this is unlikely to change.

When writing on sustainability within complex regional natural resource management (NRM) systems in 2009 Professor Graham Harris put it eloquently when he said:

"I conclude that we have strong empirical evidence of contradictory assumptions and practices in NRM, denial of complexity, inadequate philosophical bases and science, over-reliance on 'scientific management' (the philosophy of 'scientific' control – "predict-act" – has been oversold) and a consequent lack of achievement of management and policy goals. What is required is a more post-normal science; a practice which recognises the evident complexities and where the basic science addresses the trans-disciplinary challenges of balancing assets and community values and of managing "the whole of nature" […] The greatest emphasis in recent years has been on the jurisdictional collaboration and community capacity aspects of adoption pathways and policy development […] Less emphasis has been placed on the adequacy of the underlying knowledge base."

Water – we can't live without it.

'BLUE PLANET' FUTURES

'Blue planet' futures will increasingly depend on how well we use and manage our water.

We have made good progress with water science, policy, management and educational reforms. But has Australia abandoned water reform? Have we dropped the ball?

With the many challenges and opportunities ahead now is not the time to fall asleep at the wheel. We must get back on the bike!

This is combined with rapidly growing expectations of our capacity and capability to tackle problems we know about as well as those we don't. And this is not simply a scientific or engineering issue. It is a societal issue. We are obliged to explain hydrology – its challenges, complexities, societal relevance – to policy-makers, funding agencies and broader society.

In my view, there simply aren't enough productive conversations between scientists, politicians, policy-makers, media and society.

But I see a future in which water policy, water science, water management and society work together more intimately and more effectively. Society will demand it.

To solve the plethora of emerging important and complex water and environmental problems:

- we must get interdisciplinary;
- we must get out of our comfort zones;
- we must take risks;
- we must think big; and
- we must expect nothing less from ourselves.

My crystal ball tells me this for certain. ⊙

ACKNOWLEDGEMENTS

I am grateful to Dr John Williams FTSE and Professor Andrew Boulton for valuable discussions and feedback.

Professor Craig Simmons FTSE is a leading groundwater scientist, recognised for major national and international contributions to groundwater science, education and policy reform. Professor Simmons is Director of the National Centre for Groundwater Research and Training, Matthew Flinders Distinguished Professor of Hydrogeology and Schultz Chair in the Environment at Flinders University. He is Deputy Chair and member of the Statutory Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC). He is also a member of the US National Academies of Sciences, Engineering and Medicine Roundtable on Unconventional Hydrocarbon Development. Professor Simmons was named the 2015 South Australian Scientist of the Year. He is Deputy Chair of ATSE's Water Forum.

Our vision is to create sustainability and excellence in Australia's power engineering.

What is the API?

The Australian Power Institute (API) is a not for profit national organisation established by the Australian power industry to boost the quality and numbers of power engineering graduates with the skills and motivation for a career in the energy industry which encompasses:

- Generation, transmission and distribution utilities
- Manufacturers and suppliers to the industry
- Consultants to the industry
- End users of electricity in their operations.

Value Proposition

To deliver a sustainable supply of highly skilled power engineering professionals working effectively to meet the challenges of creating Australia's new energy future, and underpin the technical and commercial success of member companies in the energy sector.

The key objectives of API are to achieve the following:

- Provide a sustainable supply of quality power engineering graduates to industry
- University power engineering teaching and learning provides relevant industry skills
- Value added continuing professional development programs
- A respected organisation leading the national development of power engineering skills.

Further Information

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BY DENISE GOLDSWORTHY
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What's ahead for the minerals industry

AUSTRALIA'S BLUE-SKY FUTURE Financial margins will always be low and the increasing requirements of regulators and communities mean significant innovation is a must.

This downhole sensing tool developed by Curtin researchers represents a step change in the quality and amount of data the minerals industry can now capture.

PHOTO: CURTIN UNIVERSITY

If you put the themes of 'blue-sky' future and mining together, many people will automatically think of the Midnight Oil song from 1990 'Blue sky mine'.

This song about the disaster of mining blue asbestos at Wittenoom provides a good reminder of the significant changes that have occurred in the Australian mining industry over the past 50 years, as well as the challenges that must be addressed over the next 50 years to ensure mining remains an acceptable and significant contributor to the Australian economy.

Australian miners are known for digging things up and shipping them overseas. We do it at scale and, in many cases, at lower cost than our international competitors.

However, mining in Australia is becoming increasingly difficult. The large, low-cost, Tier 1 deposits are in some cases nearing depletion and the limited discoveries of replacement resources are bringing challenges of deeper, wetter and lower-grade ore.

Financial margins will always be low as most are true commodities, early in the value chain, with minimal leverage outside periodic supply shortages to argue for prices much above cost plus margin plus sustaining capital. Combine this with a need for new commodities to support technological advances that are likely to be geologically rarer and more distributed, as well as the increasing requirements of regulators and communities, and significant innovation is a must.

The industry represents itself as innovative but, while there are impressive examples, many opportunities are handicapped by the on-again-off-again investment strategies of the industry, its investors and financial backers, due to the swings in commodities prices.

There is also a big difference between the ability of the majors and the small-to-mid-tier miners to access the latest innovations. This critical block to adoption of industry interoperability standards or shared platforms – to enable the industry to achieve its equivalent of the Internet of Things (IoT) – is currently preventing the mass use of technology, inhibiting adaptations from other industries and preventing removal of significant entry barriers for new technology suppliers.

Australia is up to this challenge, with some of the best minds working in Australian research organisations, mining and the supporting mining equipment technology and services (METS) sector to make this happen. The shared vision for mining should be one of an industry that is physically invisible to the community, but at the front of minds for the contribution it makes to the economic and sustainable supply of raw materials necessary for a modern economy.

Delivering on this vision will require major change in four areas.

1 Mining will be considered an integral part of the community, with shared accountabilities that cross lease boundaries.

This integration will be at a deeper level than just the infrastructure. Mining will become truly integrated with its neighbours to ensure efficient management of resources (including air, water, and energy), minimisation of waste and sustainable ecosystem management.

High engagement will deliver net environmental and community benefits as regular markers of mining projects. We will take advantage of opportunities to link thinking about things coming out and things going into the ground – such as geothermal energy (heating and cooling), storage of non-mining wastes in mine voids (including carbon/CO_2 sequestration, nuclear waste and current landfill waste) and upgraded mine planning strategies, all of which will be enabled by increased data analytics capacity for complex modelling of these systems as well as the technologies to deliver repeatable performance.

This will be vital to maintain the confidence of stakeholders. Failure to do so is likely to result in more resource nationalisation agendas, so is not an option for the industry.

2 Mining will be optimised and integrated as a result of collaboration across the Australian value chains.

This will come about from deeper connections with more of Australian industry – building on the relationships with the innovative METS sector and establishing new connections with the advanced manufacturing developments so that the smart technology products manufactured in the future Australia are matched with resources mined in Australia.

We will have learnt from the lithium experience, where it took a while for Australia to match its exploration and metallurgical development activity to the foreseeable growing demand. The 'old' bulks such as iron ore, coal and alumina that are the basics for economic development won't be the core source of GDP in a sustainable future economy.

Australia doesn't have big enough local markets to ensure competitive scale, and the tyranny of distance is another handicap to new industries. Manufacturing will be revitalised by new industries such as biotech, that create small, expensive components or items, which will potentially need new raw materials that will be sourced from Australia.

This will create a high value-adding opportunity for secondary and tertiary processing in addition to the mining of the commodities of the future – all of which are likely to be at smaller scale than the current bulks.

Within the industry, knowledge will be more integrated with reduced lease boundary limitations. In the case of geological knowledge, this will be facilitated by state and federal geoscience agencies, enabling extensive, complex modelling of geological and mineralogical systems for more effective exploration.

Cooperation to develop industry-wide step-change solutions will be facilitated through an increased role of METS-Ignited (the Mining Equipment, Technology and Services Industry Growth Centre), AMIRA (the minerals companies and suppliers' research organisation), ACARP (the coal industry's research program), the Cooperative Research Centre program and similar initiatives.

3 Sensor arrays on machines and in the ground, automation, UAVs, virtual and augmented reality (VR and AR), robotics and big data analytics, often adapted from other industries, will all be widespread.

These changes will be linked to the other dimensions, reflecting the move to more selective recovery of the most valuable ore, and fundamentally reducing the scale of many operations.

These tools will eliminate human involvement in dangerous tasks, and guarantee more environmentally responsible and cost-effective performance by removing the variability inherent in people. Issues of interoperability and shared infrastructure, especially communications and data, will be overcome, with many tools developed using open-access software.

Mining applications will be a sub-market of more global strategies for technology companies. The equipment will be remotely controlled and either remotely maintained or self-maintained, enabling the workforce to live anywhere and thus providing more family-friendly conditions.

One of the double-edged-sword consequences of this change is that the high salaries of the last decade will be gone forever.

The required skill set of future miners will be as deep in STEM knowledge as any other. Much of this innovation or adaptation will come from multidisciplinary efforts, with the tools such as VR/AR complemented by data analytics allowing geologists and other professionals to explore options in every sense of the word.

4 How we mine will be different.

New metallurgical and mineral processing technologies that support fundamentally different flow sheets will be developed to respond to our unique geological and mineralogical differences as well as the need for new products and lower water and energy consuming methods that will leave a smaller global footprint.

These will be complemented with entirely new methods for *in situ* chemical or biological recovery of specific elements that eliminate the need to mine large volumes of waste to access the valuable reserves.

All the foundation pieces are there for Australia to achieve this vision for mining.

The biggest barrier to achieving the vision is not the technical or innovative capability of our people – it is the lack of the belief that such a vision is both possible and desirable.

Making the mind-set change starts with our ability to convince the younger generations at school that mining is a high-tech, challenging opportunity for them to contribute to.

Engaging with young minds while they still think 'how', not 'why not' will help us make the collective paradigm shift. ⊙

Ms Denise Goldsworthy FTSE is a non-executive director and adviser on research, technology and innovation. A former senior mining executive, she is experienced in manufacturing, mining and the technology and innovation sectors. She is currently Chairman of ChemCentre WA; a Director of the Export Finance and Insurance corporation (EFIC); a member of the Edith Cowan University Council and its Commercialisation Advisory Board; a trustee for the Navy Clearance Diver's Trust; and a judge for the Prime Minister's national science awards. She was named the 2010 Telstra Australian Business Woman of the Year, is a member of Chief Executive Women (CEW) and was inducted into the WA Women's Hall of Fame in 2011. She chairs ATSE's Minerals forum.

BY BEN EGGLETON
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Sensing our way to a bright future

AUSTRALIA'S BLUE-SKY FUTURE A multi-trillion-dollar industry – and we're right in the middle of it.

Our future in our fingers – the silicon chip.

A person with a casual interest in optical science could be excused for believing that it is a modern field of study, originating in the 20th century. Although the invention of the laser and optical fibres dates only from the 1960s, the history of optical science actually stretches back thousands of years.

Most recently this rich history was explored in the International Year of Light in 2015, a celebration of both the history of optical and photonic research and the bright future offered by this important discipline.

The truly revolutionary inventions of the laser and optical fibres in the 20th century were a major advance in the field, continuously transforming our communication systems and the ways in which modern humans can interact as a species.

Our 21st century is poised to be an era which will be defined by photonics and nanotechnology. It may seem that the global internet enabled by these technologies is already revolutionary enough, but we are only just at the beginning of the transformative opportunities offered by this technology.

Australia is well positioned to play a leading role in this future, both in terms of our capacity for fundamental discoveries and translation into new real-world technologies such as photonic sensing.

We know that photonics is the linchpin of a multi-trillion-dollar industry and itself a $500 billion global industry and an essential part of the Australian research ecosystem.

As well as underpinning the telecommunications infrastructure, photonics technologies are playing critical roles in other areas – health and medicine, defence and security, infrastructure and transport, and energy and the environment.

In these areas, photonic sensors are enabling new smart technologies that can sense and monitor the health of people, infrastructure and the environment.

Photonics sensing has been around for a long time. There are numerous examples of highly successful photonic sensors that have been deployed extensively – fibre optics that run along railway lines to measure strain and inform maintenance planning; sensors that are deployed in the mining industry to detect toxins; and current sensors that are used widely in the power industry.

Australia has a long history of leading-edge research and innovation in photonics sensors with numerous world-leading groups and centres across Australia.

RESEARCH EMPHASIS

With the advent of nanotechnology and the establishment of major nanofabrication infrastructure in Australia, the research impetus is to establish new smart sensors that are small enough and low cost enough that they can be distributed everywhere and can address the grand challenges of the future.

The NSW Government, through the leadership of our Chief Scientist and Engineer, Professor Mary O'Kane AC FTSE, has invested in the NSW Smart Sensing Network (NSSN), a collaboration between the University of Sydney and the University of New South Wales which I co-direct with Professor Justin Gooding from the University of NSW.

The Network will harness the state's significant scientific, information communication technology (ICT) and engineering capabilities across academia and industry to provide state-of-the-art solutions in chemical and physical sensing to help address major societal issues, from

In its most basic sense, photonics considers the generation, transmission and detection of photons, the building blocks of light. What we can build with these blocks is truly amazing.

ATSE

Enhancing Australia's prosperity through technology and innovation

The Australian Academy of Technology and Engineering (ATSE)

ATSE is made up of some of Australia's leading thinkers in technology and engineering. One of Australia's four Learned Academies, it's an eclectic group, drawn from academia, government, industry and research, with a single objective in mind – to apply technology in smart, strategic ways for our social, environmental and economic benefit.

To achieve that goal, ATSE has formed a variety of expert, independent forums for discussion and action – platforms to move debate and public policy on issues concerning Australia's future. These focus on agriculture, education, energy, health, infrastructure, innovation, mineral resources and water – and increasingly on climate change mitigation and ICT issues. ATSE is keenly aware of the international collaboration necessary to ensure that Australia is abreast of world trends.

It's an open, transparent approach – one that government, industry and community leaders can trust for technology-led solutions to national and global challenges. Each year, the Australian Government recognises the importance of the work we do by awarding the Academy an establishment grant to help with:

- Fostering research and scholarship in Australia's technological sciences and engineering;
- Providing and conducting administrative support, workshops, forums and events to enable the Academy and its Fellows to contribute on important national issues;
- Managing the development and execution of our programs; and
- Supporting relationships with international communities.

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AUSTRALIAN ACADEMY OF
TECHNOLOGY AND ENGINEERING

the environmental impacts of the resources industry, to security at airports and improving quality of life for our ageing population.

We are currently in an establishment phase, which is emphasising five pilot projects to address key challenges in NSW. At the same time, we are developing a network of researchers, end users and industry partners to be the basis of the next phase of development.

At the University of Sydney, we are focusing on air-quality monitors with an emphasis on developing photonic sensors to detect particulate matter and gases, particularly related to coal mining and the associated rail corridor in the Hunter Valley. The challenge is to develop low-cost and compact sensors to be the basis of a network of sensors that map the spatial and temporal spread of coal particles around the rail corridor in the Hunter Valley, to better inform residents, policy-makers and regulators of air-quality issues.

This exciting project is applying photonic sensors to a real-world issue that is not only of local concern, but also has global applicability. We expect to apply this methodology to a whole range of pollutants.

In the longer term, we will incorporate these photonic air-quality sensors on chips small enough to be part of a mobile platform, perhaps even a smart phone. This vision aligns well with the CUDOS research program, which has spent the past decade developing a photonic chip based on silicon technology – the same technology platform that is the basis of the microelectronics platform in your phone.

CUDOS, the Australian Research Council Centre of Excellence for Ultrahigh bandwidth Devices for Optical Systems, represents a consortium of six Australian universities and partner organisations all around the world, headquartered at the University of Sydney.

We now have photonic circuits that are etched into silicon wafers providing the basis of highly advanced signal processing devices. We are fabricating these 'chips' using lithography equipment already used in the semiconductor industry, meaning the techniques developed can be translated to mass production using that same equipment.

We are working with local companies such as Silanna, based in Sydney, whose silicon-on-sapphire technology is well suited to photonic sensor applications. At the same time, CUDOS is commercialising many of its inventions through spin-off companies and partnerships with local companies.

The most recent addition to the Australian photonics research community is the University of Sydney's Nanoscience Hub, part of the Australian Institute of Nanoscale Science and Technology (AINST). This new facility incorporates more than 800 square metres of state-of-the-art clean room space filled with the tools that are needed to fabricate and prototype these photonic chips.

We know that photonics is the linchpin of a multi-trillion-dollar industry and itself a $500 billion global industry.

Our long-term vision is to bring a complete laboratory onto the chip, incorporating light-based circuits (photonics) with acoustic functionalities for manipulating and actuating fluids on the microscale, in the silicon platform that allows a seamless interface with electronic components.

We are already building photonic spectroscopy techniques into the same silicon chip that performs electronic processing in your smartphone. This will enable your smartphone to perform tasks such as medical diagnosis, including analysing blood or saliva, or sense pollutants in the environment via spectroscopic analysis.

The ability to manipulate fluids will be the basis of a biological laboratory that is part of the photonic chip. Our approach is to use acoustic waves (sound) that can be generated on the chip. These are not the traditional sound waves that we hear or use in ultrasound, but ultrahigh frequency sound waves.

PHONONS

We refer to them as 'phonons', which are particles of sound, just as photons are particles of light. We are talking about hypersound – phonons with frequencies from 100 megahertz to tens of gigahertz. Harnessing hypersound on a chip enables the manipulation of microscale biological and chemical elements, meaning we can mix, sort and select and even create a centrifuge on a chip.

This 'laboratory on a chip' will literally be small enough to be part of your smart phone and built into the same silicon chip already performing digital operations, and with cloud connectivity it will allow wide-scale environmental sensing with local accuracy.

Eventually we anticipate this technology will allow your smartphone to be transformed into a sensor that will sense your local environment and personal health.

Think of it like a Twitter feed on your smartphone, except all the information is about you, your body, your health and your immediate environment – as much or as little information as you need instantaneously available.

This will allow people to make informed decisions about their health or the environment they choose to live in.

We really are sensing our way to a very bright future.

Professor Benjamin Eggleton FAA FTSE is an ARC Laureate Fellow and Professor of Physics at the University of Sydney, Director of the ARC Centre for Ultrahigh bandwidth Devices for Optical Systems (CUDOS) and co-Director of the NSW Smart Sensing Network (NSSN). He worked in the US for Bell Laboratories/Lucent Technologies before joining the university. He won the 2011 Walter Boas Medal, the 2011 Eureka Prize for Leadership in Science, the 2007 Pawsey Medal and the 2004 Malcolm McIntosh Prize for Physical Scientist of the Year. He is a former president of the Australian Optical Society.


BY GORDON WALLACE and STEPHEN BEIRNE
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What can we make in the future?

AUSTRALIA'S BLUE-SKY FUTURE The colocation of fabrication tools under the same roof as materials science and engineering research has changed how we think about making things.

Traditional manufacturing is capital intensive – make lots and make it cheap. This philosophy was most likely driven by accountants who viewed success as shaving a fraction of a cent off the cost of each manufactured product.

Unfortunately that traditional manufacturing approach took the industry on a diverging path from fundamental breakthroughs in materials science and engineering. That connection was once the backbone of the manufacturing sector.

It was fundamental breakthroughs in electroplating chemistry that gave us copper refining, it was understanding the complex chemistries between layers of polymers that gave us our current bank notes. Somehow we lost the connection between fundamental science and the ability to make things.

But there's another shift in play, and it has been an amazing experience to be part of the reconnection between science, engineering and manufacturing through 3D printing.

Contributing to the reconnection is the advent of additive fabrication, especially 3D printing. Here, structures are created layer by layer from 3D computer-aided designs. This approach enables the integration and spatial distribution of multiple materials.

Many of these materials are not amenable to traditional 'top-down' fabrication approaches. 3D printing is not capital intensive. It can be located in the research laboratory next to the researcher, or even better in a translational space that includes the researcher and end user.

These end users may be big business with an eye for new opportunities, or others ranging from plumbers to jewellers to clinicians who see the advantages to be gained in local customised manufacturing. This convergence of researchers, fabricators and end users creates an environment fertile with commercial opportunities.

SOME EXAMPLES

These examples are all made possible by 3D printing.

Plumbing supplies

Real-world use of 3D printed components is often limited by the properties of standard 3D printable materials. Chemson, specialists in PVC formulations and extrusions, have been working with the ARC Centre of Excellence for Electromaterials Science (ACES) to validate the printability and durability of a PVC filament. PVC offers considerable benefits in terms of cost and weather resistance in comparison to ABS and PLA (two commonly printed plastics).

Jewellery manufacture

Leading Australian designer and metalsmith Cinnamon Lee specialises in using 3D computer modelling and rapid manufacturing processes in conjunction with traditional gold and silversmithing techniques to produce work that explores the intersection between technology, the machine and the hand-made. To achieve the high-resolution detail demanded by her designs, we used 3D metal printing with a range of titanium alloys.

Printing titanium alloys for jewellery.

Surfboard fins

Surfboards are often custom made to match a surfer's ability and the conditions in which the board will be used. But the fins, the critical control surfaces of a board, can only be bought 'off the shelf'. This project challenges the need to rely on the limitations of conventional mass manufacturing production techniques and uses additive fabrication to provide surfers with a set of fins tuned to their taste, feel and needs.

Microtonal flutes

A collaboration between musicians, acoustic engineers and additive fabricators, this project used mathematical models to create 3D designs of flutes with custom tuning patterns. The accuracy and speed of additive fabrication allows for repeatable and reliable replication of custom designs as robust and viable instruments that musicians successfully played at the 2014 Darwin and OzAsia Festivals in Australia.

Glaucoma implants

Implants are used to regulate the pressure in the eye of glaucoma patients. Surgeon Michael Coote has accumulated ideas for improvements over a number of years. 3D printing enabled us to create a range of prototypes and this accelerated developments in this area.

Emerging opportunities

Two areas in which we are actively engaged within ACES are energy conversion/storage and medical bionics.

Building better surfboards.

These new commercial opportunities are being driven by low-footprint, flexible, on-site 3D printing capabilities.

A 3D-printed flute.

In these areas researchers around the globe have amassed a number of fundamental science discoveries over the past two decades. These involve new electromaterials: compositions that have electronic, mechanical and chemical properties that take the performance of electrodes to a whole new level.

An interesting and topical example is graphene, shown to have properties that enable fabrication of new electrode structures for energy storage (e.g. battery electrodes) and conversion (e.g. solar cells). It has also been shown to have extraordinary properties when used as an electrode for bionic applications.

The need to combine graphene with other biomaterials and even bioactive entities has drawn on the capabilities of 3D printing. We have developed protocols that enable the 3D printing of biomaterials compatible with living cells. Such biomaterials include alginate (extracted from brown seaweed) and ulvan (from green seaweed). The latter is developed via a collaborative venture with a seaweed farmer, Dr Pia Winberg, from Venus Shell Systems (Nowra, NSW).

We have been engaged in a number of studies wherein cells are introduced to the 3D scaffold after printing (e.g. to facilitate cartilage regeneration from adipose stem cells). There are further possible advantages to be gained by printing such cells with the 3D structure.

We have managed to achieve this for cartilage regeneration using a cross-linkable gelatin to provide the structure. We have also demonstrated the ability to create 3D printed structures containing cortical neurons, a critical first step in our 'brain on the bench' project as we strive to print structures to provide insights into neuronal diseases. We have also developed a bioink capable of printing human neural stem cells.

As we travel on this journey to deliver highly complex structures containing living cells we have discovered that the ability to arrange even the most simple materials in clever ways can deliver unprecedented performance.

FABRICATING THE FUTURE

There will always be a place for high-volume, low-cost manufacturing. However, with the need for customised, often highly functional structures, a new manufacturing industry is emerging.

These new commercial opportunities are being driven by low-footprint, flexible, on-site 3D printing capabilities. The localised nature of this new manufacturing industry is putting innovators alongside fundamental research scientists/engineers and end users such as clinicians, musicians and trades people.

We are now well placed to build on 30 years of advances in materials science and use 3D printing to create unprecedented structures and devices. The use of the 3D printing approach means that we can combine and arrange materials into structures that previously were not possible.

The colocation of fabrication tools under the same roof as fundamental research into materials science and engineering has changed how we think about making things.

We have discovered that the stockpiles of knowledge accumulated in the three decades of the nanotechnology and biomaterials revolutions can now be put to use.

The ability to create is back in the hands of the creative!! ⊙

Professor Gordon Wallace FAA FTSE is Director of the ARC Centre of Excellence for Electromaterials Science (ACES) and Director of the Australian National Fabrication Facility ANFF (Materials Node) at the University of Wollongong. He is involved in the design and discovery of new materials for use in health and medical technologies as well as in energy conversion and storage. This involves using new materials to develop biocommunications from the molecular to skeletal domains in order to improve human performance via medical bionics and to transform and store energy, including novel wearable and implantable energy systems. He was recently appointed to the Prime Minister's Knowledge Nation 100 and received the Eureka Prize for Leadership in Science and Innovation in 2016.

Dr Stephen Beirne is a Senior Research Fellow at the University of Wollongong's Intelligent Polymer Research Institute (IPRI) and Additive Fabrication Manager at the Australian National Fabrication Facility Materials Node. Since joining IPRI in 2010 he has been responsible for the implementation of a suite of commercial and custom additive fabrication tools for the development of novel energy and biofabrication devices produced by IPRI. His research focuses on materials processing methods by means of inkjet printing, extrusion printing and selective laser melting techniques.

BY TANYA MONRO
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What can we learn from our best research?

AUSTRALIA'S BLUE-SKY FUTURE In many of the fundamental disciplines – from physics and astronomy through to the creative arts – Australia's researchers are well above world standard.

Research is all about asking questions. And what separates good research from great research is the quality and nature of the question.

But what drives researchers and, in particular, what shapes their questions? And does it matter?

In recent years the Australian research ecosystem has been in the grip of a debate about the impact of the research we do and what can be done to remedy the relatively poor engagement that exists between our industries and our universities, according to OECD reports.

The underlying assumption is that surely if we were able to drive the commercialisation of more of our research and better connect the worlds of business and academia we would be poised to benefit as a nation from innovation-driven economic growth and the creation of high-value jobs for our children.

This is cast as a battle between pure and applied research and between short-term problem solving and long-term, curiosity-driven knowledge creation – a battle that, with some notable exceptions, sees an unbridgeable gulf between most of our research academics and the communities and industries that might potentially benefit from their knowledge.

To the contrary, Australia's best research is transformative, impactful and fundamentally curiosity-driven. It is founded on deep creativity and strong long-term partnerships with research end users who shape the directions in which it travels, and the questions that the researchers frame and pursue.

In many of the fundamental disciplines – from physics and astronomy through to the creative arts – Australia's researchers are well above world standard.

Answering the questions posed by research is the relatively easy part. The process of answering well-posed research questions is the part of the research endeavour that comes closest to mirroring the stereotypical views most children have of scientists – people in white lab coats who, step-by-step, follow a recipe, applying the tools and methodologies of the discipline in which they have received intensive training until they become the world expert in one tiny sliver of knowledge.

Put this way, deep disciplinary expertise seems an isolating and potentially irrelevant burden. Fortunately this is far from the truth since deep, disciplinary-based excellence is at the core of the research endeavour.

As the ATSE Industry Engagement work – the REA – shows, it underpins the capacity to

UNISA RESEARCH HIGHLIGHTS

Some examples of outstanding research at the University of South Australia, which is currently celebrating its 25th birthday year:

- Dr Colin Hall, one of our outstanding researchers from the Future Industries Institute, was recognised as the inaugural winner of the Prime Minister's Emerging Innovator award for his role in the development of all-plastic automotive mirrors. This simple-sounding yet technologically challenging application of coating science to a practical need means that millions of vehicles now have safer and lighter componentry;
- Dr Siobhan Banks is doing outstanding work in the Centre for Sleep Research in understanding how shift work and diet impact function, and how the impact of sugar intake in children is informing revisions to guidelines;
- Professor Alex Brown and his team at the SA Health and Medical Research Institute (SAHMRI) are focused on addressing the health challenges faced by Australia's indigenous people;
- Professor Sharad Kumar in the Centre for Cancer Biology is exploring programmed cell death and its role in ageing and cancer, in partnership with SA Health;
- Professor Ian Olver AM in the Sansom Institute for Health Research is making insights from cancer research accessible to everyone and relevant to our everyday choices and decisions;
- Professor Fiona Arney, Chair and Director, Australian Centre for Child Protection, and her team have developed insights leading to a child-centered view of how we might better support our most vulnerable citizens;
- Professor Ina Bornkessel-Schlesewsky and her colleagues at our Cognitive Neuroscience Laboratory have undertaken pioneering work in understanding how the human brain processes language; and
- Professor Byron Sharp, leading the Ehrenburg Bass Institute for Marketing Science, has developed marketing science insights leading to industry sponsors better understanding what shapes the value of their brand and the economic impacts that have flowed as a result.

engage. as well as having intrinsic value.

Research is, at its heart, a creative industry and one that draws communities, industry and universities together, immeasurably enriching the society in which we live.

Most universities around Australia have many rich examples of high quality research and dedicated researchers and have powerful and engaging stories to tell about their research.

There is no question that as a sector we need to get better at telling these stories in order to dispel the misconceptions that have come to the surface in the current debate about industry engagement and impact. It's also critical as a way of encouraging more bright young people into research, and especially the STEM disciplines.

By considering only the value embedded in the products, policies and services that research enables is a very limited and narrow view of the value of our best research.

Arguably the greatest impact our research has is embedded in the experiences and learning of our undergraduate students.

Being taught by active researchers who are thought leaders in their fields internationally is inspiring and, when this is combined with contributions from practicing professionals, creates an educational offering that is not only current and applicable, but also instils the innovation elements critical for future professional development and evolution in a world where work is changing fast.

So what does this tell us? There is no question that we need to encourage and incentivise partnerships between researchers and the potential end users of their research.

But before we do that we need to get much better as a nation at nurturing interdisciplinary research because real-world challenges don't respect discipline boundaries. We also need to create critical mass in areas of national research priority rather than direct scarce research funding to areas according to which areas may scream the loudest.

By doing so we will clearly build our nation's capacity to face significant global challenges as well as strengthening our economic and social resilience while simultaneously raising educational outcomes for our graduates.

We need to change our narrative from being one of deficit, where we talk of chances not seized, to one of a rich tapestry, where research is inseparable from the communities it benefits.

Critical to this is increase the mobility of people between industry and academia, supported by co-location and precincts so well developed that it is is difficult see the where the academy ends and the real world begins. ⦿

Professor Tanya Monro FAA FTSE is Deputy Vice-Chancellor Research and ARC Georgina Sweet Laureate Fellow at UniSA. Her research is in photonics with a focus on sensing and lasers. She received a Royal Society Fellowship at the University of Southampton before becoming inaugural Director of the University of Adelaide's Institute for Photonics and Advanced Sensing and the ARC Centre of Excellence for Nanoscale BioPhotonics. She is a member of the Prime Minister's Commonwealth Science Council, the CSIRO Board, the SA Defence Advisory Board and the SA Economic Development Board. Awards include: Eureka Prize for Interdisciplinary Scientific Research, South Australian of the Year, SA Scientist of the Year and the Prime Minister's Malcolm McIntosh Prize. She is a Vice President of ATSE.

PHOTO: CALUM ROBERTSON

Colin Hall with the plastic car mirror.

FERRIS BACKS CALLS FOR GREATER COLLABORATION

Bill Ferris

Mr Bill Ferris AC, Chair of Innovation and Science Australia, has called for greater collaboration between Australian businesses and its publicly funded research institutions.

Mr Ferris told a Sydney audience that matching our research excellence with translation and commercialisation excellence was Australia's greatest challenge and opportunity.

"Better translation of research into commercial outcomes underpins economic growth and global competitiveness," he said.

"If we fail to translate research into commercial outcomes, we will sell Australia short on jobs, economic growth and quality of life."

"A future Australia must be propelled by its knowledge intensive sectors, one such stand-out sector is health and medical research." he said.

Driving increased collaboration between business and research institutions is a key objective of Innovation and Science Australia. The upcoming audit of Australia's innovation system and the following 2030 Strategic Plan will provide whole-of-government advice on encouraging collaboration and increasing Australia's rates of research commercialisation.

Mr Ferris strongly urged his audience to seek opportunities to collaborate on translating research findings into commercially viable products and services.

"There needs to be more development and clinical trialling, much greater enthusiasm and respect for funding spin-offs and commercialising ventures, and respect for those who take this risk," Mr Ferris said.

BY BETH WOODS
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Getting the best from our land

AUSTRALIA'S BLUE-SKY FUTURE Feeding a global population of nine billion people by 2050 will drive demand for more efficient technology in our livestock and agricultural industries.

We grow great houses. Arguably, this is not the best use of our good quality agricultural soils, but most of us choose to live on the fertile floodplains of Australia's coastal zone.

Our terrestrial ecosystems and land resources face a number of competing demands from our towns and cities, farming and mining. From the elegant complexity and diversity of our soil ecosystems to landscape-scale catchment processes, our land resources remain largely undervalued and poorly understood.

Getting the best from our land requires us to consider the central role our soils and landscapes play in supporting our quality of life.

While we can't really do much about the fact that historically in Australia our homes and our communities were often built on our best quality land, we can improve our collective understanding of our land resources and think about how we best use, protect and manage what remains.

It is important that our best quality cropping lands be retained for that purpose and that sustainable farming practices are utilised. The decline in arable lands – either through development or through poor agricultural practices that can lead to erosion, salination, or simply the loss of productivity through overuse – concerns me greatly.

The World Resources Institute estimates that nearly 40 per cent of the world's agricultural lands are depleted in some way. The injudicious use of inorganic fertilisers, pesticides and herbicides can also reduce the productive capacity of our land over time.

However, precision farming, sustainable agricultural practices and pest-resistant crops are reducing these impacts.

CULTURAL CHANGE

Australian agricultural products are recognised as high quality due to the high standards they are required to meet in terms of food safety and environmental performance. Not all agricultural production around the world is subject to the same expectations.

The choices we make about what to put on our plates will be key in feeding our planet's growing population in a changing climate. Social trends in relation to food drive demand and ultimately what is produced. Social trends that aim to address the challenges of global food security, improved health and wellbeing, reducing greenhouse gas emissions and meeting the demand for renewable energy will affect what is grown in the future, and where.

The kilojoules produced by cropping to feed animals exceed the kilojoules contributing to the human diet by about 8:1, so an increased future proportion of cropping for human consumption seems likely. Subtle shifts away from crops for animal feed to crops for human consumption and biofuels are already taking place.

Equally, feeding a global population of nine billion people by 2050 will drive demand for more efficient technology in our livestock and agricultural industries.

CLIMATE CHANGE

The decreased rainfall and increases in extreme heat events projected for much of Australia pose specific adaptation challenges for agriculture.

Increased temperatures result in additional stress on plant and animal production systems and implications for food safety with more energy required to safely store and distribute food.

The Consultative Group on International Agricultural Research, a partnership of 15 research centres around the world, estimates that the global food system – from fertiliser manufacture to food storage and packaging – is responsible for up to one-third of all human-caused greenhouse gas emissions.

The sector also faces a significant mitigation challenge. Greenhouse gases are emitted by activities such as livestock production, soil disturbance, land clearing, farm machinery use, production and use of fertiliser and transporting produce and inputs.

MY WORK SPANS QUEENSLAND'S AGRICULTURE, FISHERIES AND FORESTRY INDUSTRIES AND OUR CENTRAL CHALLENGE IS INCREASING PRODUCTIVITY AND PROFITABILITY WHILE PROTECTING OUR VALUABLE LAND AND WATER RESOURCES. I ACKNOWLEDGE THE SCIENCE AND POLICY EXPERTISE OF MY COLLEAGUES IN THIS ARTICLE AND HOPE IT INSPIRES YOU TO CONTRIBUTE YOUR SKILLS AND EXPERTISE TO THE PUBLIC POLICY CHALLENGES OF 'GETTING THE BEST FROM OUR LAND'.

PHOTO: CSIRO

Demand for crops such as pulses and legumes is rising and the UN International Year of Pulses 2016 marks their value – providing protein and improving soil quality and carbon storage.

Emissions may be reduced by activities such as using biofuel or feeding strategies for ruminant livestock designed to lower methane produced by enteric fermentation. It is estimated that at least 18 per cent of all greenhouse gas emissions globally are produced by the livestock sector.

Carbon farming is managing soil, vegetation, water and animals to increase carbon storage or reduce greenhouse gas emissions. Organic matter, although only a small proportion of our soils (two to 10 per cent), plays a critical role in the physical, chemical and biological function of agricultural soils. Increasing soil organic carbon is widely regarded as beneficial to soil function and fertility and has been associated with increased agricultural productivity.

With soil being considered a major world carbon sink, increasing the amount of organic carbon in agricultural and rangeland soils is seen as one way of mitigating climate change.

Consequently, there is great interest in quantifying the ability of various soil types and land management practices to increase and retain net organic carbon inputs.

CREATIVITY

There is a long and proud tradition of innovation within Australia's agricultural sector and recent advances in agricultural technology tend to be of two types – biological and digital.

Queensland has been a world leader in the development of precision agriculture. Just 120 years after the first gasoline-powered tractor was produced, the sophisticated farm machinery of today integrates data from satellite observations and on-ground instruments to apply the appropriate amounts of seed, water, fertiliser, and so on.

Breeding advances using molecular approaches are leading to more productive and nutritious crops.

Retail and packaging innovation also influence agricultural decisions. The Internet of Things assists the tracking of food from the farm gate to the restaurant plate and everywhere inbetween. Packaging that can connect to the global data grid is transforming what used to be a container for product to an intelligent technology that will help us address safety and traceability issues.

COLLABORATION

Communication and knowledge sharing will remain central to our success in managing our land resources in the digital age. No one individual or organisation can know everything there is to know.

Strong partnerships between growers and advisers, suppliers, buyers, retailers and each of us as consumers will be needed as we learn to deal with the massive complexities that emerge from rapid change and innovation in the management of our land resources. ⊙

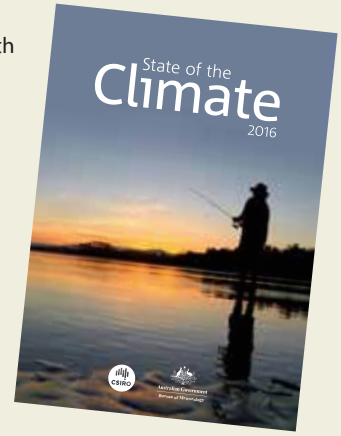
Dr Beth Woods OAM FTSE is Director-General of the Queensland Department of Agriculture, Fisheries and Forestry. She was the foundation Director of the University of Queensland's Rural Extension Centre, and Professor of Agribusiness at UQ from 1997 to 2004. Dr Woods has served on the CSIRO Board, the Gatton College Council and the Rural Adjustment Scheme Advisory Council. She has chaired the Rural Industries R&D Corporation, the Australian Centre for International Agricultural Research, the National Drought Policy Review and the International Rice Research Institute. She was a member of the Australian Rural R&D Council (2011-12) and currently chairs WorldFish.

MORE HEAT AND FIRE, SAYS CLIMATE REPORT

Australia is experiencing more extremely hot days and severe fire seasons according to the findings of a new climate report.

State of the Climate 2016 is the fourth report in a series published biennially by CSIRO and the Bureau of Meteorology. Key facts from the report include:

- Australia has warmed by about 1°C since 1910;
- the number of days each above 35°C has increased in recent decades, except in parts of northern Australia;
- there has been an increase in extreme fire weather, and a longer fire season, across large parts of Australia since the 1970s;
- May-July rainfall has reduced by about 19 per cent since 1970 in south-west Australia;
- April-October growing season rainfall has reduced by about 11 per cent since the mid-1990s in continental south-east of Australia;
- rainfall has increased across parts of northern Australia since the 1970s;
- global sea level has risen over 20 cm since the late 19th century, with about one third of this rise due to ocean warming;
- the 2016 global annual average CO_2 level will almost certainly exceed 400 ppm;
- the overwhelming contribution to the additional CO_2 in the atmosphere is from human activities, mainly the burning of fossil fuels; and
- atmospheric CO_2 increases in 2015 were the highest ever observed.



ATSE IN ACTION

ATSE HOSTS ACOLA ROUNDTABLE

ATSE, on behalf of ACOLA, hosted a roundtable in Canberra in November to discuss promotion of the findings of the Securing Australia's Future Reports 04, 09 and 10.

These reports are a synthesis of Australia's foremost experts from industry, academia and government considering the key issues facing Australian productivity.

Attendees at the roundtable were provided an overview of the findings from the research with case studies provided by key stakeholders who had engaged in particular practices that had enhanced their productivity, through linking innovation and knowledge.

The roundtable was well attended by senior representatives across each sector, who engaged in insightful discussion, largely focused on:

- the importance of incentives and measures in raising business productivity;
- facilitating knowledge transfer between researchers and end users; and
- skills-mixing in innovative businesses.

Dr John Bell FTSE addresses the roundtable.

CHEMISTRY MUST CONTRIBUTE

The world faces challenges that are too complex to be solved by a single individual or organisation, but the science and business of chemistry must make a major contribution to the solution, according to Mr Ross Pilling.


Ross Pilling (left) talks to Geoffrey Vaughan.

In an address to ATSE's Victorian Division Mr Pilling explored the opportunities for chemistry and its obligations to future generations.

Mr Pilling, a former Chairman and Managing Director of BASF Australia and New Zealand, said the world population and its demands would keep growing, while the planet's resources were finite.

If nothing changed, we would need the resources of almost three of our planets to meet the demands of the population.

Access to a reliable energy supply, clean water and other non-renewable resources would become increasingly difficult and it would be necessary to enhance nutrition quality.

ATSE IN ACTION

API solar cars in 200 STELR schools

ATSE'S STELR program – in conjunction with long-term sponsor Australian Power Institute (API) – has celebrated the 200th STELR school in Australia to receive an API solar car class set.

Cameron Tuesley gives Linus Power some tips on solar cars.

The event was celebrated at Park Ridge State High School in Brisbane, which was the 200th school to engage with the solar car activity as part of the STELR (Science and Technology Education Leveraging Relevance) program focused on bringing a new approach to science and technology learning to Australian high school students.

API has been supporting STELR with the solar cars program since 2012. Each car is valued at $70 and a class set at about $1000. Schools apply for sponsorship, successful schools receive a class set free of charge.

Successful schools also receive a visit from a power engineering student who holds an API Bursary to assist with their study costs. The bursary holder visits the school once or twice to help with construction of the cars, judge a race between the students' solar cars and talk to students about careers in power engineering.

Key guests at the Park Ridge celebrations were Mr Linus Power, the Queensland Parliament Member for Logan, Ms Sharon Amos, Principal of Park Ridge SHS, and Park Ridge SHS Head of Science, Mr Ross Bradford. The event was also attended by ATSE STELR staff.

A highlight of the celebrations was the display of a Clenergy Team Arrow car (Clenergy Team Arrow is Australia's premier solar racing team). Mr Cameron Tuesley, Clenergy Team Arrow founder, was a guest speaker.

Australian Power Industry CEO Mr Mike Griffin said API was gratified that 200 Australian schools were now participating in the solar car program.

"Having this number of schools and students involved is a clear signal that our partnership with ATSE in focusing students on power engineering and alternate energy sources is bearing fruit," he said.

RAW MATERIALS IN THE SPOTLIGHT

ATSE was involved in putting research and innovation, education and outreach, and industry and trade in raw materials in selected non-European countries under the spotlight at a recent INTRAW workshop in the UK.

Representatives of INTRAW's joint panel of experts met to validate reports on the three topics – part of the process towards proposed establishment of the European Union's International Observatory for Raw Materials (INTRAW).

ATSE is the Australian partner organisation of the project consortium and was represented at the meeting by Dr Matt Wenham, Executive Manager Policy and Projects. ATSE's contribution to the project has been informed by an expert reference group of Fellows, led by Ms Denise Goldsworthy FTSE.

The EU-funded INTRAW project started in early 2015 to map best practices and boost cooperation opportunities related to raw materials between the EU and five technologically advanced non-EU countries (Australia, Canada, Japan, South Africa and the US). The outcome of the mapping and knowledge-transfer activities will become a baseline to set up and launch the EU's International Observatory for Raw Materials as a permanent international body to establish and maintain strong long-term relationships with the world's key players in raw materials technology and scientific developments. It is funded under the European Commission's Horizon 2020 Program for Research and Innovation and is coordinated by the European Federation of Geologists.

ACADEMIES JOIN ON ICT CAMPAIGN

ATSE and the Academy of Science recently co-hosted a meeting in Canberra to address the urgent need for the development and implementation of a high-level national strategy to guide the development of Australia's Information and Communication Sciences, Engineering and Technology (ICSET) capabilities.

Representatives from industry, philanthropic sectors, professional organisations and academia identified emerging issues, technologies, and key themes that should be addressed in such a plan including:

- cybersecurity;
- big data and data analytics;
- machine learning and artificial intelligence;
- the Internet of Things;
- high-capacity broadband;
- school, vocational and university education and training;
- workforce pathways;
- policy, protocols, standards and regulation;
- infrastructure; and
- public engagement.

The organisations that attended have been invited to form a working group to develop a national ICSET strategy.

Professor Rod Tucker FAA FTSE, Chair of the Academy of Science National Committee for Information and Communication Sciences, and Professor Glenn Wightwick FTSE, Chair of the ATSE Forum on ICT, are the leads for each academy.

ATSE IN ACTION

IMNIS wins $200,000 grant and B/HERT award

IMNIS, the Academy's PhD student mentoring scheme, has been approved to receive a grant of $200,000 over two years from the MTPConnect Project Fund Program.

The funding will be $150,000 in year one and $50,000 in year two, which is to be matched dollar-for-dollar with industry funding and will augment the IMNIS program (Industry Mentoring Network In STEM), which is already operating pilot projects in Victoria, South Australia and Western Australia.

The ATSE program was also acclaimed at the national Business/Higher Education Round Table (B/HERT) national awards in November, taking out the award for the Best Higher Education and Training Collaboration 2016.

The B/HERT Award was made jointly to ATSE and the key IMNIS partners – AusBiotech, Techin/BioSA, La Trobe University, the University of Melbourne, Monash University, RMIT University, the University of South Australia, Flinders University, the University of Adelaide, the University of WA, Edith Cowan University, Curtin University, Murdoch University and Mentorloop.

The IMNIS program aims to develop a national mentoring program linking PhD students in STEM with senior industry mentors who can provide advice and role models of industry-based STEM careers and narrow the cultural gap between business and academia.

Over the past two years programs have been established in three states with 100 PhD students from 11 universities partnering with industry groups such as AusBiotech, Engineers Australia (WA) and TechinSA (formerly BioSA) to recruit leading professionals in their fields to mentor these students.

The MTPConnect grant was announced by Industry, Innovation and Science Minister Greg Hunt at an AusBiotech conference in Melbourne. AusBiotech partnered with ATSE in the funding application.

This project will expand the successful Victorian IMNIS pilot in biotechnology to all states in collaboration with AusBiotech which will be responsible for recruiting mentors. The focus will be on PhD students in all fields of relevance to the medical technology and pharmaceutical industry sector.

Currently there are 50 mentors and mentees in the Victorian program from four universities (Melbourne, Monash, La Trobe and RMIT). Mentors are recruited by direct approaches to professionals in the field and include people with skills in R&D, marketing, IP, finance and manufacturing. These mentors are matched one-to-one with the PhD students and the program is administered using software from Mentorloop.

IMNIS has another program with TechinSA in South Australia and three universities (Adelaide, UniSA and Flinders). It was launched in May 2016, is still enrolling participants and currently has 18 paired Mentors and Mentees.

IMNIS also has a pilot program in WA in the Minerals and Energy sector with four universities participating (UWA, Curtin, Edith Cowan and Murdoch). Discussions are underway with groups in Queensland and NSW to engage in the IMNIS program.

IMNIS Principal Professor Paul Wood FTSE said collaboration between business and publicly funded research organisations (PFROs) was crucial to improving the translation of research into productivity.

"By developing a new generation of PhD students who have a better understanding of industry and the skills it values we hope to create a more innovation-focused culture within the biosciences community," he said.

"With only 10 per cent of PhD students finding long-term academic positions it is critical that they develop skills outside of their specific technical area. If the future PhD students do not see and understand the opportunities beyond an academic career then the number of people entering PhD programs may be significantly reduced."

GOVERNMENT ACCEPTS RESEARCH TRAINING RECOMMENDATIONS

The Australian Government has accepted all six recommendations made by the Australian Council of Learned Academies (ACOLA) to improve Australia's research training system, resulting from its report *Review of Australia's Research Training System*.

The Minister for Education and Training, Simon Birmingham, and the Minister for Industry, Innovation and Science, Greg Hunt, said the review found improvements should be made to ensure Australia's research training system remains internationally competitive.

The ACOLA project was undertaken by an Expert Working Group (EWG) consisting of Fellows from the four Learned Academies, with expertise in research, higher education and industry. It was chaired by Mr John McGagh FTSE, former Head of Innovation at Rio Tinto.

It notes Australia's industry–university collaboration performance lies close to last among international competitors – a situation it says is unacceptable for a nation striving to transition to an innovation-driven economy.

"There is an urgent need for Australia to address this issue," the report says.

"We encourage the university sector to develop a range of industry engagement models in research training to drive proactive industry–university collaboration. We encourage industry to engage with universities in order to benefit from the skills and expertise of researchers."

THE REPORT'S SIX RECOMMENDATIONS FOCUSED ON THE FOLLOWING.

1. Implementing the recommendations flowing from its key findings.
2. Reducing red tape.
3. Incentivising industry–university collaboration.
4. Developing a national program to support industry placements for research doctorate candidates.
5. Monitoring results.
6. Increasing encouragement for Indigenous participation.

ATSE IN ACTION

ATSE backs the R&D Tax Incentive Review

ATSE generally supports the outcomes of the review of the R&D Tax Incentive conducted by Bill Ferris AC, Chair of Innovation Australia, Dr Alan Finkel AO FAA FTSE, Australia's Chief Scientist, and Mr John Fraser, Secretary to the Treasury.

"The reviewers have produced a clear and considered analysis of the scheme, along with a sensible set of recommendations for how it can be strengthened and improved," said ATSE in its submission to the review.

"It is vital that this investment of almost $3 billion be maximised to provide an effective incentive for collaboration and innovation."

ATSE said the Review's recommendation of a premium rate to the Incentive for businesses that collaborate with publicly funded research organisations (PFROs) mirrored international evidence it had gathered showing a number of high performing innovation countries offered premium rates for collaboration in their tax incentive schemes.

"Introducing a premium rate for collaboration will complement other measures in the National Innovation and Science Agenda (NISA) aimed at boosting engagement between industry and research, such as the introduction of metrics to measure and incentivise collaborative behaviours by researchers and universities."

ATSE noted that the Review recommended that this premium rate be available to businesses that employ recent PhD graduates, echoing a finding from the Australian Council of Learned Academies (ACOLA) review of research training that the value of higher degree graduates be made more evident to Australian industry.

Consistent with the ACOLA review, the Government should consider extending this provision to recent research Masters degree graduates, ATSE said.

It was worth noting that one of the objectives of the original R&D tax concession, when introduced in 1985, was to improve linkages between business and public sector research organisations. Given that the Incentive represents such a significant amount of public money being directed to private businesses, it was important to ensure that this tax expenditure derived an additional benefit to the nation through improved collaboration.

The proposed collaboration premium provided "an elegant way" to improve linkages between business and PFROs without penalising businesses that were unable to participate in collaborative partnerships.

The full submission is on the ATSE website.

FELLOWS VISIT DESAL PLANT

SA Water recently provided a special technical tour for a group of ATSE Fellows of its Kauwi Interpretive Centre to inspect the desalination plant.

They went into the 40-metre-deep cavern containing the intake pumps and then into the parallel outfall shaft in which two 650-kilowatt turbines recover energy from the hydraulic head as the brine returns to the outfall 1000m off-shore. The group then visited the pre-treatment filtration system and the submerged membrane ultrafiltration step, followed by the reverse osmosis banks and the remineralisation, chlorination and fluoridation stages.

The desalinated water is blended with water from the Happy Valley Reservoir.

SA Division Chair Mike Heard in discussion the visit with SA Water host Matt Blaikie.

BEYOND COAL SHINES THE LIGHT ON ENERGY

The ATSE NSW Division held a capacity-crowd, one-day symposium in Sydney in November on the future of electricity generation.

Beyond Coal: What will power NSW? was framed by the transition away from coal in a carbon- constrained environment and in a market subject to increasingly disruptive change.

Key organiser Mr George Maltabarow opens the symposium.

More than 130 people attended the Symposium, which addressed issues of demand growth; consumers who are also producers; the speed of the transfer and technical challenges in moving to low-emission technologies; the mix of generation technology options; and the likely investors.

The Symposium brought together a range of speakers with unmatched expertise who were well placed to provide fresh insights. Key speakers came from AEMO, CSIRO, General Electric, AGL, the NSW Department of Investment and Industry, Transgrid, the Commonwealth Bank of Australia and the Grattan Institute.

The keynote address was made by Mr Peter Littlewood, Former Operations Director, CLP Hong Kong (formerly China Light and Power).

WOMEN IN TECHNOLOGY

Discrimination still key to gender pay gap

A lot of steps to pay equity.

PHOTO: ISTOCK

A new report by KPMG Australia, *She's Price(d)less: The Economics of the Gender Pay Gap*, has found that sex discrimination continues to be the single largest factor contributing to the gender pay gap – now at around 16.2 per cent – and it's on the increase.

The report – prepared for the Diversity Council Australia (DCA) and the Workplace Gender Equality Agency (WGEA) – focuses on understanding the drivers of the gender pay gap, which is critical to designing interventions to close the gap.

The report uses structured econometric modelling to determine the factors that underpin the gender pay gap, and to what extent they contribute. The report is partnered with an Executive Companion document highlighting a range of tactical improvement opportunities and supported by case studies from some of Australia's leading companies.

"The drivers of the gender pay gap are complex. They include a broad range of factors including human capital and educational qualifications, on-the-job training and accreditation, work experience and tenure," said Ms Susan Ferrier, National Managing Partner for People, Performance and Culture at KPMG Australia.

"Critically, they also include labour market discrimination – where skilled individuals may face different earning potential and employment opportunities due to discrimination by gender, values and culture."

Ms Libby Lyons, Director, Workplace Gender Equality Agency, said: "The gender pay gap is a powerful symbol of lost potential for individuals, businesses and the economy. Understanding the factors that lead to women being consistently undervalued in the workforce is critical to creating change."

DCA CEO Ms Lisa Annese said: "Clearly we need to redouble our efforts to address the gender pay gap. And while organisations can do a lot to close the gap in their individual workplaces, there are structural inequities between industries and in the wider economy which must also be addressed. Business, government and the wider community all have a role to play."

Key findings include:

- systemic sex discrimination remains a persistent feature of the workforce and accounts for a growing proportion of the gender pay gap, up from 35 per cent in 2007 to 38 per cent in 2014;
- traditional gender predominance in selected industries and occupations jointly accounts for 30 per cent of the gap – female-dominated industries such as healthcare and social assistance remain lower-paid sectors compared to professions normally occupied by men;
- part-time employment now only accounts for four per cent of the gender pay gap, down from 14 per cent in the 2009 report; and
- interruptions in work history also factor strongly on the gender pay gap, increasing from nine per cent to 21 per cent between 2007 and 2014.

GENDER EQUALITY SCORECARD SHOWS SOME GAINS

Women make up half of the nation's workforce but earn only 77 per cent of men's average full-time income, according to the latest gender equality scorecard, released in November.

The scorecard shows the average full-time female employee took home $26,853 less than the average male employee in 2015-16, with the salary difference rising to $93,884 at the top level of management.

Women are also under-represented in leadership roles, holding just 16.3 per cent of CEO and 37.4 per cent of all manager roles.

However, the scorecard shows improvement in key gender equality indicators with lower pay gaps, greater movement of women into management roles and increased action from employers to address gender equality.

The third year of data collected by WGEA for the scorecard covers more than 12,000 employers and four million employees.

This year's report highlights the sharp divide between male and female-dominated industries, showing that 60 per cent of Australians work in an industry dominated by a single gender and graduates are overwhelmingly entering fields dominated by their own gender.

The scorecard is at wgea.gov.au

TWENTY WOMEN AT PERTH STEM ROUNDTABLE

Twenty women leaders in engineering and technology, mining, oil and gas, construction, astronomy, mathematics, health sciences and robotics met at Government House, Perth, recently at the Women in STEM Roundtable to discuss collaboration for change.

Community and government sectors, business and higher education were also represented, with the event hosted by the WA Governor, Hon Kerry Sanderson AC.

The event was funded by the WA Department of Local Government and Communities and was convened by Women in Technology WA (WITWA), a volunteer group that works to encourage young people, especially girls, to study STEM subjects and to support women in STEM professions.

Discussion focused on the spectrum of women's experiences in STEM careers, including 'the empty pipe' – young women choosing not to pursue STEM careers – to the 'leaky pipe' – women leaving STEM careers.

Professor Lyn Beazley AO FTSE, Patron of WITWA, chaired the discussion.

WOMEN IN TECHNOLOGY

"Women must reach their full potential"

Research Citation Awards were presented to the top 12 Australian early to mid-career women in research – based on their track record of citations since 2009 – at the inaugural Women in Research Citation Awards event in Canberra in October.

Dr Susan Pond AM FTSE, a member of ATSE's Gender Equity Working Group and a member of the SAGE Expert Advisory Group, and Dr Wafa El-Adhami, Executive Director of SAGE, were guest speakers.

Dr Pond emphasised the importance of ensuring that women reach their full potential in research and contribute fully to the competitiveness of our universities, research organisations and innovation system.

"We don't have time or talent to waste," she said.

Drawing attention on the organisational structures and rules that contribute significantly to the under-utilisation of women, Dr Pond introduced the equality-by-design principles of the UK's Athena SWAN Charter and the role of the Science in Australia Gender Equity (SAGE) Program, in which ATSE is a partner with the Academy of science.

The SAGE Program is bringing the Athena SWAN to Australia as a pilot in 40 Australian Universities and Research Institutions.

Award schemes continue to be crucial to celebrating achievement and performance, Dr El-Adhami said.

"Today's celebration of Australian Women Researchers is a further demonstration of the commitment across the higher education and research sector to advance gender equality and diversity in Australia – a sector that has committed and embarked on the SAGE journey.

"Events like this impart important benefits – not least because they acknowledge and commend achievements. They create the stories and narrative for now and for future generations."

But she sounded a caution.

"Valuable as they are, history tells us that recognising and rewarding individual achievement alone has limited impact on advancing gender equality and diversity," she said. "It is rewards that recognise a whole of system change that become critical for sustainable transformation."

Susan Pond (left) and Wafa El-Adhami.

The event was convened by Clarivate Analytics (formerly the IP & Science Business of Thompson Reuters) and the Australian National University.

SARAID BILLIARDS JOINS SAGE TEAM

Dr Saraid Billiards has joined the SAGE team in Canberra as Head of Strategy and Engagement. Prior to her secondment to SAGE, Dr Billiards was the Director of the Research Grants team at the National Health and Medical Research Council (NHMRC). She was responsible for managing and delivering several funding schemes including Project Grants, Development Grants, Targeted Calls for Research and International Collaborations, with an annual budget of approximately $500 million.

Saraid Billiards

She was also responsible for the NHMRC's Women in Health Science Committee – established to identify barriers and enablers to the progression and retention of women in health and medical research. Dr Billliards has a PhD in perinatal neurophysiology and undertook her postdoctoral training at Harvard Medical School and the University of Melbourne.

Science in Australia Gender Equity (SAGE) is national program promoting gender equity and gender diversity in science, technology, engineering, mathematics and medicine (STEMM). SAGE is a partnership between the Australian Academy of Science and ATSE. It is piloting the Athena SWAN program – an evaluation and accreditation framework from the UK that addresses the improvement of gender equity policies and practices in STEMM.

BUSTING MYTHS ABOUT WOMEN IN STEM

A new paper from the Office of the Chief Scientist highlights the need for ongoing action to encourage and support women to pursue careers in science, technology, engineering and mathematics (STEM).

Busting the Myths about Women in STEM dispels four damaging and persistent myths facing women in STEM. It is accompanied by an illustrated datasheet showing Australia's gender STEM imbalance persisting from the classroom to the workplace.

Australia's Chief Scientist Dr Alan Finkel AO FAA FTSE said the nation needed to build a culture that further encourages girls and women to enter and excel in STEM fields.

"Australia is already a global leader in science. Imagine what we could achieve if women and men felt equally welcomed and appreciated in STEM professions," Dr Finkel said.

"This paper will help equip Australians with the facts about gender inequality in STEM, and help us to continue the progress already being made in this area."

The paper highlights that women are just as talented and capable as men in STEM fields, but the gender pay gap, workplace discrimination and a belief that STEM professions are 'male' roles discourage girls and women from pursuing these careers.

NEWS

Smart drones count koalas

Local councils near Brisbane are testing a new tool for protecting their vulnerable koala populations – drones equipped with artificial intelligence (AI) and backed by powerful statistical analysis.

Koala experts with Logan, Gold Coast and Tweed councils are working with a multidisciplinary team of QUT researchers and unmanned aerial vehicle (UAV) specialists to develop and trial technologies they hope will prove cheaper and more accurate than current tracking methods.

The researchers have been conducting test flights over koala habitats in each region, coinciding with ground-based koala counts.

The koala-counting drone.

QUT aerospace engineer Associate Professor Felipe Gonzalez said the team had developed a unique combination of UAV with thermal imaging, statistical modelling and AI.

"Using small drones to take images is becoming more common but we know of no others combining this with cutting-edge analytical technologies that draw meaning from those images," Professor Gonzalez said.

"We've found thermal imaging can detect even well-camouflaged koalas effectively and our counting and tracking algorithms can allow us to differentiate the shape of a koala from a possum, bird or other animal.

"This project is concentrating on koala populations but the technology can easily be adapted for other species, be they native or pest species, like wild dogs or feral cats."

The project has already proved the technology can save councils valuable time. In one test, it took humans more than two hours to conduct the same survey a UAV took just 30 minutes to complete.

39 IDEAS WIN CSIRO ON PRIME BACKING

A non-invasive diagnostic test to improve IVF success rates and an electronic nose that can detect illegal trafficking of wildlife contraband are among 39 'big ideas' being fast-tracked through the nation's sci-tech pre-accelerator, ON Prime.

ON Prime is part of the ON program, powered by CSIRO and designed to create connections between research, science and business. It is enabling the 39 successful teams to be armed with the skills to not only validate their science and technology ideas in the laboratory, but also in the marketplace.

The teams commenced the eight-week program in one of five ON Prime 'hubs' across the country from late September, supported by funds provided through the National Innovation and Science Agenda.

Some projects that will be fast-tracked through ON Prime include:

- an acoustic belt that listens to, records and analyses gut noises to aid diagnosis and treatment of patients suffering from irritable bowel syndrome or other gastrointestinal conditions;
- a new tool for winemakers that captures and interprets historical, real-time and forecast data to help improve decision-making and increase wine quality and crop outputs;
- new contrast imaging technology that improves X-ray image sensitivity and quality, allowing doctors to 'see the invisible' in tumours and soft tissue while reducing patients' radiation dose;
- an empathy simulator that allows high-quality, cost-effective virtual training of health and aged-care workers to improve communication skills and empathy; and
- new processes for apple juice producers to reduce or re-use the byproducts of juice manufacture to create new food products and markets while reducing landfill and greenhouse gas emissions.

CSIRO Chief Executive Dr Larry Marshall FTSE said he was overwhelmed by the quality of applications and appetite for entry.

"We're thrilled to have created this program for Australia's research sector and can't wait to see the breakthroughs that come from this round of ON Prime," Dr Marshall said. "The potential impact these ideas will have on the everyday lives of Australians and our economic, social, and environmental prosperity is huge."

Applications for ON Accelerate – the ON experience designed to build market-validated ideas, and develop and test business models – opened on 4 October 2016, with 10 positions available for research teams across the country for a program commencing next January.

ANSTO HELPS DATE KHMER HISTORY

Radiocarbon dating using accelerator mass spectrometry at ANSTO's Centre for Accelerator Science has helped reconstruct the history of an ancient Khmer archaeological site in Cambodia.

Dates were determined for samples that were retrieved from sediment collected at the Preah Khan of Kompong Svay temple complex, about 100 km of the famous seat of the medieval Khmer kingdom, Angkor. Jungle has now grown over the 22 km^2 site, a vast peripheral outpost that was the largest single temple compound erected during the Angkorian Empire.

The research at Preah Khan was carried out by investigators from the universities of Sydney, Illinois and Alberta along with ANSTO.

PHOTO: KARL SCHWERDTFEGER, CSIRO

Researchers collaborate.

NEWS

PHOTO: SIMON ANDERS

Greg Hunt inspects UNSW's quantum labs with Michelle Simmons.

$70 million for quantum computer in silicon

The University of NSW has struck a $70 million deal to create a consortium to develop and commercialise technology that could lead to the world's first quantum computer in silicon.

The four-way agreement between UNSW, the researchers, business and the Federal Government is expected to pave the way for the development of a prototype silicon quantum integrated circuit – the first step in building a functional quantum computer.

UNSW says its team is the only research group in the world that can make atomically precise devices in silicon.

The scientists and engineers, within the ARC Centre of Excellence for Quantum Computing and Communication Technology (CQC²T) led by Professor Michelle Simmons FAA FTSE, hope to have built a 10-qubit circuit within five years.

Industry, Innovation and Science Minister Greg Hunt announced the $70 million consortium during a recent tour of the Centre's new quantum computing laboratories, opened by Prime Minister Malcolm Turnbull in April.

In funding already announced, the Government has contributed $25 million over five years to the consortium through its National Innovation and Science Agenda, complementing $25 million from UNSW, and $10 million each from the Commonwealth Bank of Australia and Telstra. Other partners are expected to join the consortium to bring the founding investment to $100 million.

The CQC²T is a collaboration of six Australian universities – UNSW, the Australian National University, the University of Melbourne, the University of Queensland, Griffith University and the University of Sydney – and 12 international university and industry partners.

The ARC recently extended funding to the CQC²T as a Centre of Excellence. This funding, comprising $34 million in government contributions and $103 million in cash and in-kind support from participating organisations, supports the Centre's fundamental research over the next seven years.

Mr Hunt said the announcement was the culmination of negotiations over the IP of the technology development and was an example of how governments, universities and business could work together to translate great research into commercial reality.

Quantum computing had the potential to revolutionise the industries of the future, solving in hours or minutes problems that would take conventional computers – even supercomputers – centuries, he said.

"The Government has supported our fundamental research over many years and this new agreement is a unique opportunity that will allow us to do things that we would not be able to do under the normal research banner in Australia," Professor Simmons said.

"It is a phenomenal opportunity for us to prototype potentially transformational quantum computing technology here in Australia, and be the first in the world to build 10 qubits (of quantum circuitry) in five years," she said.

Mr Hunt set Professor Simmons and her team a goal of producing "at least one Nobel laureate over the next 20 years".

$416 MILLION IN ARC GRANTS

The Australian Government will fund 989 new research projects at a cost of more than $416 million as part of the Australian Research Council's National Competitive Grants Program.

THE SCHEMES FOR WHICH PROJECTS HAVE RECEIVED FUNDING INCLUDE:

- Discovery Projects for funding commencing in 2017 – $234.7 million for 630 projects;
- Discovery Indigenous for funding commencing in 2017 – $4.6 million for 11 projects;
- Discovery Early Career Researcher Award for funding commencing in 2017 – $71.7 million for 200 projects;
- Future Fellowships for funding commencing in 2016 – $77.0 million for 100 projects; and
- Linkage, Infrastructure, Equipment, and Facilities for funding commencing in 2017 – $28.6 million for 48 projects.

Minister for Education and Training Simon Birmingham said the funding was a crucial investment in growing a smart Australia, driving innovation and delivering real outcomes that benefit all Australians.

"This funding represents a significant investment in a wide variety of fundamental and applied research projects, growing Australia's research capacity and infrastructure, and supporting the next generation of researchers," Mr Birmingham said.

NEWS

Healthcare and marine research dominate

Healthcare initiatives dominated the results of the Australia 2016 Google Impact Challenge, with research initiatives by the George Institute, the Centre for Eye Research and Hello Sunday Morning being named joint winners, with grants of $750,000.

Marine research initiatives – from The Great Barrier Reef Foundation and the Nature Conservancy – took out the winners' titles in the People's Choice category.

- The George Institute for Global Health was awarded for its Textcare initiative – an SMS-based system to support people with chronic disease live healthier lives. It uses computerised algorithms to compose personalised messages and educational and motivational content to patients and aims to help the half of the population living with chronic disease and save the Australian healthcare system up to $5 million.
- The Centre for Eye Research Australia was acclaimed for its eyesight self-assessment system for remote communities, using its 'Vision At Home' concept that can provide for rural, elderly and mobility-affected Australians to test their eyesight 'at home'.
- Hello Sunday Morning, a movement aiming to establish a better drinking culture in Australia, was awarded for its personalised Daybreak App designed to change individual's relationships with alcohol – particularly those who can't access available treatments.
- The Great Barrier Reef Foundation, working with Queensland University of Technology, was a People's Choice winner with its RangerBot – a multi-function, autonomous underwater vehicle designed to monitor water quality, map reefs and help manage invasive species.
- The Nature Conservancy Australia shared the People's Choice award for its FishFace project, which will automate the collation, at sea, of information on the species and numbers of fish caught, and use this data to inform management decisions. FishFace will be trialled initially in Indonesia's deep-water snapper and grouper fisheries, with the potential to be rolled out to fisheries everywhere.
- The Australian Maritime Environment Protection Association was named a finalist for its proposal for an information repository, through a dedicated online portal, to provide more than 3000 ports around the world with access to data about ship-idling emissions, which contribute to global warming and can harm the health of nearby cities.
- World Vision Australia was also a finalist, unveiling a new innovation in fire-detection technology that could protect millions of people living in the world's slums. The key innovation is that the Lumkani detector responds to rapid temperature rise, rather than smoke, allowing it to work in homes where open flames are used for cooking, heating and lighting.

The Lumkani heat detector: fire-detection technology for the developing world.

Automating fish data.

WOODSIDE USES MATHS TO SCHEDULE VESSELS

Perth-based oil and gas company Woodside is streamlining its offshore operations with the assistance of new mathematical models, developed in collaboration with a team of Curtin University academics, to schedule the support vessels that service Woodside-operated offshore facilities.

The vessels deliver supplies and assist with loading oil to oil tankers.

The most cost-efficient vessel routes are influenced by various constraints, including time windows, vessel speeds, cargo capacities and off-loading capability.

The mathematical models previously used were so large that state-of-the-art optimisation software packages struggled to find good solutions, leading to the Curtin team working up new solution algorithms.

"One outcome of the project was providing Woodside with strong evidence for a business case to reduce the support fleet from four to three vessels – this is a significant saving since the cost of running an additional vessel is considerable," said Curtin's Associate Professor Ryan Loxton, who led the project.

A state-of-the-art offshore support vessel.

PHOTO: SIEM OFFSHORE

"Another outcome was modelling the implications of changing the vessel schedule from a 'taxi-style' service whereby vessels would service facilities on demand, to a regular fixed schedule that is easier to deliver in practice."

NEWS

CSIRO says its six Future Science Platforms are critical to turning Australia's future challenges into opportunities.

CSIRO unveils its six new Future Science Platforms

CSIRO plans to grow its investment in new areas of breakthrough science to more than $52 million a year by 2020 through the creation of six Future Science Platforms (FSPs) to underpin innovation in health and biology, resources, agriculture and manufacturing,

CSIRO Chief Executive Dr Larry Marshall FTSE believes investing in challenging and riskier science will ensure research continues to meet the needs of industry, community and the environment in a rapidly changing world.

"Exactly as planned in Strategy 2020, we've freed up resources to enable this initial $17 million investment in 2016-17 to launch the FSPs, growing to over $50 million per year by 2020," Dr Marshall said.

"The platforms fuel deeper collaboration across disciplines as we tackle things that haven't been done before, which is exactly what we need to stay ahead of accelerating global disruption of all kinds from economic to environmental.

"The platforms empower CSIRO's strategy of solving Australia's toughest challenges, and getting science off the lab bench and into people's hands as quickly as possible to improve Australia's sustainability and prosperity."

Some FSPs will draw on big data to make strides forward for health and environment, some use CSIRO's precision science to transform biological systems and others focus on our deep knowledge of resources and manufacturing to create more sustainable industries to support the jobs of tomorrow.

CSIRO'S SIX FUTURE SCIENCE PLATFORMS:

- Environomics – unlocking genetic and other knowledge from our vast species biodiversity to preserve and manage ecosystems under environmental change, better manage economically useful species, detect biosecurity threats and create new products based on previously unknown biological data.
- Synthetic Biology – design, fabricating and constructing new biological parts, devices, systems and machines, as well as redesigning existing biological systems for useful purposes. Synthetic biology enables revolutionary advances in cellular factories, designer organisms and biological devices.
- Deep Earth Imaging – discovering the previously undiscovered minerals, energy and water resources that lie deep under the earth or sea. The science of Deep Earth Imaging will help us more precisely image subsurface geology to unlock the potential of this vast and relatively underexplored area.
- Digiscape – helping agricultural industries to be more productive and providing more valuable knowledge to environmental policy makers through a new generation of decision tools. Using sensors, data visualisation, artificial intelligence and assisted decision-making to generate timely and relevant advice and insights will allow better choices for more productive and sustainable outcomes.
- Probing Biosystems – driving a revolution in healthcare and agriculture, using devices and systems that obtain real-time information from living organisms about their health and well-being. This will lead to the ability to provide health and medical interventions that are timely, customised and highly specific.
- Active Integrated Matter – reinventing fields as diverse as manufacturing, agriculture, emergency services, infrastructure and mining through combining advanced materials, robotics, sensing technologies, data processing and autonomous capabilities. New forms of autonomous robots will operate safely in dangerous environments, while smart materials will enable new types of customised and personalised products and services.

RESEARCH KEY TO THE HEALTH SYSTEM

Some 88 per cent of people rated 'basing healthcare on the best and most recent research' as the most important opportunity to improve our health system – ahead of reduced waiting times in emergency departments, which came out at 80 per cent – in a recent poll conducted for Research Australia. CEO of Research Australia Ms Nadia Levin said that the results clearly demonstrated the importance of health and medical research not only to doctors, nurses and scientists, but also to patients.

"Images of queued ambulances or people in emergency departments may make good headlines, but people know translating good research into practice is the critical goal," she said.

"This poll shows a hunger in the community for our health system to be responsive to the latest research and to adapt its practices to take advantage of new discoveries as soon as possible.

"Care based on first-class research that has been translated into medical practice is something that Australians care about, and it will save Australian lives."

The poll was conducted by Roy Morgan for Research Australia, an advocacy alliance of 160 organisations in the health and medical research sector, which is committed to advancing medical innovation.

BY BRIAN O'BRIEN
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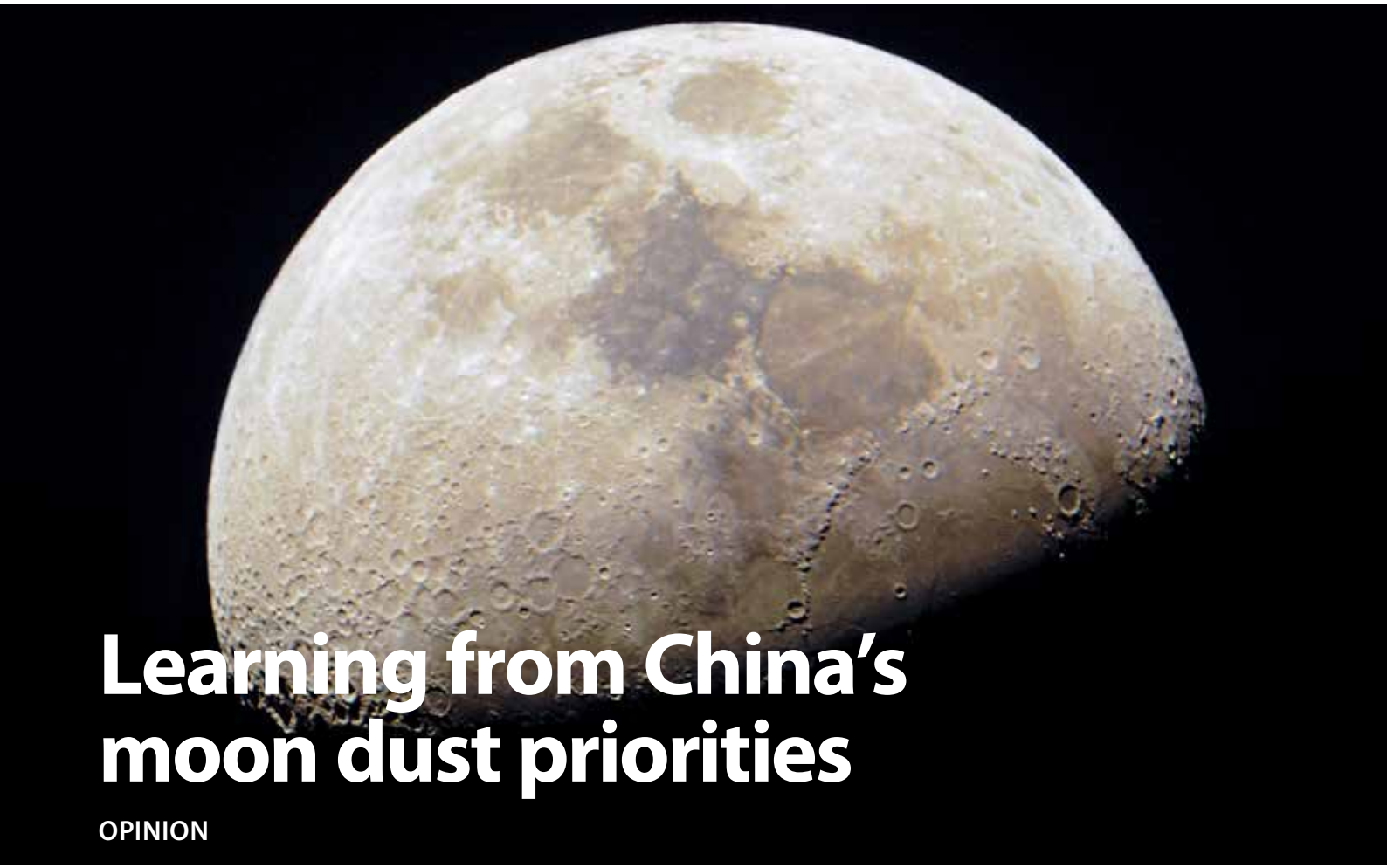


Learning from China's moon dust priorities

OPINION

China has revised the scientific priorities of its Chang'e-4 lunar rover in 2018, making it the first spacecraft out of more than 20 manned and robotic missions to the Moon to give highest priorities to studies of lunar surface floating dust.

This followed new information from the Chang'e-3 Yutu spacecraft. The first lunar rover in 40 years, during its first lunar day in December 2013 Yutu moved 100 metres, leaving deep tracks of its six wheels through dust. Unexpectedly, in January 2014 after its first sunrise Yutu was immobilised and remained immobile, despite its electronics functioning until August 2016.

In December 2015 Monique Hollick and I published peer-reviewed material on discovery of dust storms caused by sunrise on the Moon (*Focus* 193). Such sunrise-driven dust storms likely caused immobilisation of Yutu, consistent with reports by US Apollo 17 astronaut Gene Cernan, the last man on the Moon, about adhesion of lunar dust "to everything, no matter what kind of material, ... no matter what it be, and it's restrictive, friction-like action to everything it gets on".

The revision of the Chang'e-4 mission to place highest priority on dust has increased the credibility of this suggestion but not proved it.

Our Apollo-enabled scientific discoveries about lunar dust appear to bridge the two latest Chang'e steps in China's advance to put humans on the Moon in 2025–30. China's mission revision breaks the half-century Apollo mindset dismissing the importance of lunar dust, a major obstacle in our 50-year quest to publish knowledge about movements of lunar dust measured by the Apollo Dust Detector Experiments I invented in 1966, deployed by Apollo 11, 12, 14 and 15 (*Focus* 158).

The 20th century Apollo methodologies of managing complex technologies and engineering, were once acclaimed as setting global models of systems analyses. But with Cernan reporting "We can overcome other physiological or physical or mechanical problems except dust", clearly Apollo left lunar dust as unfinished business.

China's revisions qualify its high-level methodologies targeting its national objective of landing humans on the Moon, comparable to Apollo. We can set high-level realistic roadmaps – National Assessment Programs (NAPs) – for complex Australian national goals based on technology, engineering and science to have three staged objectives:

Yutu's tracks in the moon dust.

1 Define and articulate in unmistakably clear words a single target (e.g. land humans on the Moon by 2025–30).

2 Identify and articulate each stage and the purpose of each stage in the context of the single target (e.g. Chang'e-3 in 2013–16 and then Chang'e-4 in 2018).

3 Adopt innovative modifications of each new stage and its purposes when directly relevant ground-truth information from a previous stage becomes available (e.g. revise objectives and designs of Chang'e-4 because of evidence-based new Ground truth information from Chang'e-3 Yutu).

We now look to China's 21st century methodologies to refresh and reassess an important Australian policy issue with decades-old belief systems, climate change, focused since Paul Keating in 1990 on national goals of limiting greenhouse emissions from human activities to a Toronto target, then a Kyoto target. Morphing from such greenhouse goals is a gaggle of Renewable Energy Targets (RETs) made under state or federal laws, leading to competing industries with different goals, always greenhouse gases.

However, CSIRO and the Bureau of Meteorology acknowledge that "Australia's (warming) trend (is) occurring against a background of year-to-year variability. Australia's climate is famously variable". Contrasting effects on rainfall of El Niño and La Niña are now commonly reported in the media. There is consensus among scientists that such variabilities existed before the industrial revolution caused increased greenhouse concentrations. Science, technology and engineering are tools to manage real-world combinations of climate change and climate variability. While emissions can be regulated, natural variability cannot.

The 2016 Paris Agreement or treaty-in-making may seem to be a paradigm shift in making its objective not a limit to greenhouse concentrations but "to keep a global temperature rise this century well below 2ºC above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5ºC". In reality both those global future temperatures are estimated from about 40 computer models of greenhouse scenarios in Coupled Model Intercomparison Project (CMIP5) datasets from the International Panel on Climate Change (IPCC) Fifth Assessment Report released in 2013 (AR5). No one model is nominated by the UN expert IPCC as preferred to "generate projections of future climate conditions". The objective is more diffused than Kyoto, and either less or not accountable.

Meanwhile, Australia attempts to deal with present-day priorities and realities of the need for reliable 24/7 and low-cost electricity supplies and the immediate need to understand and reliably forecast local and regional climate changes within a few days and up to the next planting or harvesting or agistment seasons.

Several challenges being addressed include:

- escalating and variable costs of electricity, a state-wide blackout in South Australia and an urgent need to rationalise and implement a cost-effective and sustainable national electricity network; and
- CSIRO and the Bureau of Meteorology are being significantly reorganised;

We do not yet know whether these challenges articulate or acknowledge the necessity of a single objective for Australia's policy on climate change (as in NAP Objective 1 above) – define and articulate in unmistakably clear words a single target.

Professor Brian O'Brien FTSE, from the University of WA's School of Physics, has been involved in cosmic physics for nearly 60 years. He is a former Deputy Chief Physicist of the Australian National Antarctic Research Expeditions in Melbourne, Associate Professor of Physics at the State University of Iowa, Professor of Space Science, Rice University, Texas and First Director of Environmental Protection and Chairman of the WA Environmental Protection Authority. He has operated a strategic and environmental consultancy since 1978 and was appointed Adjunct Professor of Physics at UWA in June 2009 after returning to analyses of the Apollo dust detector experiments.

PARKES MAKES MARK IN BREAKTHROUGH LISTEN

Breakthrough Listen, the 10-year, $100-million astronomical search for intelligent life beyond Earth – launched in 2015 by internet entrepreneur Yuri Milner and Stephen Hawking – has made its first observations using CSIRO's Parkes radio telescope in NSW.

Parkes has joined two US telescopes, the Green Bank Telescope in West Virginia and the Automated Planet Finder at Lick Observatory in California, in their ongoing surveys to determine whether civilisations exist elsewhere and have developed technologies similar to our own.

After 14 days of commissioning and test observations, 'first light' for Breakthrough Listen at Parkes was achieved in November with an observation of the newly discovered Earth-size planet orbiting the nearest star to our Sun, Proxima Centauri.

A red dwarf star 4.3 light years from Earth, Proxima Centauri is known to have a planet ('Proxima b') orbiting within its habitable zone, the region where water could exist in liquid form on the planet's surface.

Such 'exo-Earths' are among the primary targets for Breakthrough Listen.

CSIRO's Parkes radio telescope is perfectly positioned to observe parts of the sky that can't be seen from the northern hemisphere, including the centre of our own Milky Way galaxy, large swaths of the Galactic plane, and numerous other galaxies in the nearby Universe.

Breakthrough Listen will use 25 per cent of the science time available on the Parkes radio telescope over the next five years.

Dr Andrew Siemion, Director of Berkeley SETI Research Center and leader of the Breakthrough Listen science program, said the chances of any particular planet hosting intelligent life-forms are probably minuscule.

"But once we knew there was a planet right next door, we had to ask the question, and it was a fitting first observation for Parkes," Dr Siemion said.

"To find a civilisation just 4.2 light years away would change everything."

NEWS

Future fibres flourish in Geelong HUB

The Future Fibres Hub, launched at Deakin University's Waurn Ponds campus, near Geelong, is a $13.2 million ARC R&D centre funded through the Federal Government's Industrial Transformation Research Program, and supported by industry and Deakin.

Located in the Deakin Institute for Frontier Materials (IFM), it aims to lead the development of future-fibre-based materials, ranging from short polymer fibres for the medical, textile and industrial sectors to carbon fibre composites for the automotive industry.

"The Future Fibres Hub will bring together world-leading fibre research and industry experts to create innovations in carbon fibres, nanofibres and high-value fibre applications," said Deakin Vice-Chancellor Professor Jane den Hollander.

"It will allow us to continue to make important advances in medical procedures, such as human tissue engineering, through to safer clothing for activities like motorcycle racing and better, lighter and cheaper carbon fibre materials for the automotive sector.

"This will help position Australia as a leader in fibres research and development and provide jobs in Geelong."

– DEAKIN VICE-CHANCELLOR PROFESSOR JANE DEN HOLLANDER

"This will help position Australia as a leader in fibres research and development and provide jobs in Geelong."

The Hub involves Swinburne University of Technology and five industry partners:

- HeiQ Pty Ltd – providing unique functional short polymer fibre materials to the medical, textile and industrial sectors globally;
- Carbon Revolution Pty Ltd – a pioneering manufacture of one-piece carbon fibre automotive wheels;
- Quickstep Automotive Pty Ltd – designing and developing carbon composites for the automotive industry;
- Draggin Jeans Pty Ltd – leading world development of protective denim apparel; and
- Ear Science Institute Australia Inc – researching and treating of ear and hearing disorders.

The Hub also involves partner investigators from CSIRO, and six international higher education institutions – Massachusetts Institute of Technology (MIT), the University of Oxford, the University of Applied Sciences and Arts Northwest Switzerland (FHNW), the Swiss Federal Laboratories for Materials Science and Technology (EMPA), the University of Southern Mississippi (USM) and Tufts University.

TINY SATELLITE WILL HELP CALIBRATE JINDALEE

A miniature 'cubesat' satellite that will play an important role in developing Australian Defence space capability is ready for launch into orbit after passing gruelling tests that simulate the harsh environment of space.

A team of space engineers from UNSW Canberra (the University of New South Wales' campus at the Australian Defence Force Academy) and Defence Science and Technology Group, put the satellite through its paces in 24/7 thermal cycling, with the help of spacecraft test engineers from the Australian National University at the Advanced Instrumentation Technology Centre on Mt Stromlo.

"The cubesat that we tested is the first of two in a joint program called Buccaneer to build Australian capability to develop and fly satellite missions," says Professor Russell Boyce, Director of UNSW Canberra Space.

Buccaneer will perform calibration experiments for Australia's world-leading over-horizon Jindalee Operational Radar Network (JORN) from low earth orbit, several hundred kilometres above the surface of the Earth. It will also contribute to aspects of UNSW Canberra Space's research program, looking at ways to more accurately predict the orbits of space objects.

"Satellites and space debris move around erratically due to space weather and atmospheric drag, even at high altitudes. These movements are not well understood and so are very hard to predict, and are a major reason why collisions in space are a serious risk," Professor Boyce says.

"Being able to avoid collisions in space is essential if we are to safeguard the space-based technologies upon which the world depends."

UNSW Canberra has made a $10 million strategic investment to build a domestic space program, which includes assembling a team of space engineers and scientists.

"Part of our investment involves bringing world-class Australian space talent back from the international space sector and reversing the brain drain," says UNSW Canberra Rector, Professor Michael Frater FTSE.

"UNSW Canberra is playing a key role in the transformation of space technology and helping Australia to become an important space-faring nation in ways that make economic sense and meet national needs."

UNSW Canberra offers Master of Space Engineering and Master of Space Operations degrees.

UNSW Canberra Space engineers, Dr Philippe Lorrain and Mr Arvind Ramana, tuning the Buccaneer.

PROFESSOR PETER GRAY FTSE, former ATSE President
DR MATT WENHAM, Executive Manager, Policy and Projects ATSE

Lifting our performance in research collaboration

OPINION The forward and back lines of innovation are our universities and businesses and those in the game know that they haven't been working all that well together of late.

PHOTO: ISTOCK

Kicking goals.

Australians seem endlessly interested in how all the various parts of our sporting endeavours have cooperated – or not – to produce the results we expect.

In the innovation game, we've been going through a similar analysis, although perhaps without the same column inches or public attention.

The two major parts of our innovation system, where the bulk of our research and its translation takes place, are our universities and businesses – the forward and back lines of innovation, if you like.

Those in the game know that the two parts haven't been working all that well together of late, with evidence from the OECD telling us that our collaboration between universities and industry goes on somewhere near wooden spoon levels. We all know that this isn't good enough, and that kicking goals in the innovation game will mean we need to do much better.

The latest contribution has come from three veterans of the game – the so-called "Three F's" (Ferris, Finkel and Fraser) – with their review of the R&D Tax Incentive.

At almost $3 billion, the Incentive is by far and away the largest lever the Government can pull to incentivise collaboration and innovation. And the reviewers have produced a clear and considered analysis of the scheme, along with a sensible set of recommendations for how it can be strengthened and improved.

In particular, the Review has recommended a premium rate to the Incentive for businesses that collaborate with publicly funded research organisations (PFROs) – our universities and research agencies. This recommendation mirrored international evidence gathered by ATSE, which showed a number of high-performing innovation countries that offer premium rates for collaboration in their tax incentive schemes.

Significantly, the Review recommends that this premium rate be available to businesses that employ recent PhD graduates, echoing a finding from the Australian Council of Learned Academies review of research training that the value of higher degree graduates be made more evident to Australian industry.

The panel's recommendations were based on the finding that the current Incentive does not encourage collaborative R&D, citing evidence that collaboration more than triples the likelihood of business productivity growth.

One of the barriers to improving R&D collaboration in Australia has been the tendency for each part of the team to blame the other for performance failures. The Review has given us a set of strong recommendations to address the role of business in collaborating effectively, but we must also look at the other component – our universities and research organisations.

For several years, ATSE has been spearheading the development of measures of the research engagement between our PFROs and industry, which would sit alongside the existing Excellence in Research for Australia (ERA) measures of research quality to provide a balancing exercise that demonstrated the value placed by the community on both basic and applied research.

The Australian Research Council and the Department of Education and Training have now been charged by the National Innovation and Science Agenda with developing an engagement and impact assessment to be conducted in conjunction with the next ERA round in 2018.

ATSE has continued to conduct work, in collaboration with universities, to support this process.

The recommendations of the Review, along with initiatives such as research engagement measures, have the potential to significantly improve our innovation process. The coach of our innovation team – the Government – needs to ensure it is working to encourage the best from all the players and allowing them to use their strengths to cooperate effectively.

If we can get that right, we could open the way for a new and exciting era where Australia's high-quality research is successfully translated to drive the high technology industries that create high value jobs and export opportunities.

And if we're very determined, we might end up being just as well known for our innovation performance as our sporting prowess.

NEWS

Harnessing sun, wind and batteries

A world-leading project combining solar, wind and battery storage will be built near Hughenden in North Queensland, delivering renewable energy on demand.

A Windlab and Eurus Energy joint venture to build the first $120 million phase of Kennedy Energy Park – consisting of 19.2 MW (AC) solar photovoltaic (PV), 21.6 MW wind and 2 MW/4 MWh battery storage – will have up to $18 million in recoupable grant funding from the Australian Renewable Energy Agency (ARENA).

The project is a pilot for the next phase, 'Big Kennedy', which is planned to include up to 600 MW of solar PV and 600 MW of wind and the potential for multiple storage options such as large-scale battery and regional pumped hydro storage – which is comparable to large coal-fired plants in Queensland like Tarong or Stanwell.

ARENA CEO Mr Ivor Frischknecht said the project would provide reliable and affordable power and highlight a pathway towards around-the-clock renewable energy.

"Kennedy Energy Park will be the first time a combined large-scale solar, wind and battery installation has connected to Australia's national electricity market," Mr Frischknecht said.

"Wind will generate power throughout the day and night, while solar ramps up during peak demand times when the sun is shining. Battery storage will smooth out power delivery from both sources, dispatching it when it's needed most and increasing overall reliability.

"The park will be connected to the Ergon Energy network and add to the growing portfolio of ARENA-supported fringe-of-grid projects in Queensland."

The project is scheduled for completion in 2018.

"Ergon will use it as an opportunity to better understand how renewables can enhance a weak part of the network and how different renewable energy technologies can work together to serve the dynamic power requirements at a grid connection point."

• Windlab is an international wind energy development company established to commercialise world-leading atmospheric modelling and wind-mapping technology. Eurus Energy is a Japanese non-listed renewable energy company – a joint venture between Toyota Tsusho Corporation and Tokyo Electric Power Company – which engages in development of and investment in renewable energy projects in the global market.

Wind-solar energy gathering.

ANSTO JOINS THE ITER FUSION PROJECT

ANSTO has signed an agreement with the ITER International Fusion Energy Organisation to join an international consortium of countries lending expertise on the ground-breaking ITER fusion project in southern France.

This is the first time a non-ITER member country has reached a technical cooperation agreement to work on the project, and connects the Australian community of fusion experts with those from the ITER nations – European Union, China, India, Japan, Russia, the US and South Korea.

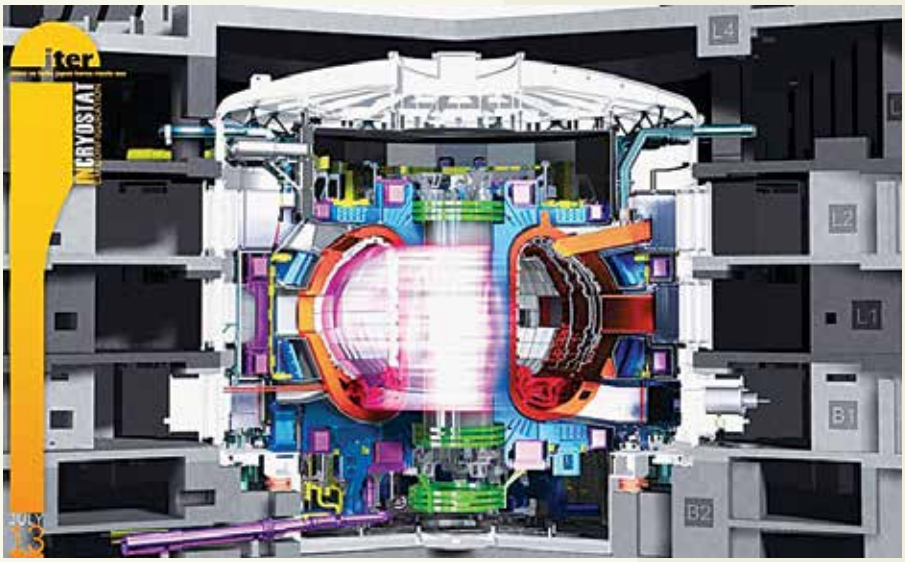
Seven member entities, comprising 35 countries, are collaborating to build ITER – the largest engineering project in the world. Scheduled to begin operations in 2025, ITER will be the first fusion device to produce more energy than it consumes.

Major components of ITER are being constructed by the member nations around the world and assembled at the ITER site in France.

Australian researchers and innovators will now work with international experts on this massive engineering project, determining the feasibility of fusion energy as a large-scale, greenhouse-gas-free energy source.

ANSTO CEO Dr Adi Paterson FTSE, speaking in France, said the agreement marked "a landmark day in the history of nuclear science" in Australia.

"Fusion is the Holy Grail for energy production and if achieved at a large-scale



Inside a tokamak.

NEWS

Microgrid project near Perth a first

Perth company Carnegie Wave Energy is set to design and build the world's first renewable energy island 'microgrid' that includes wave energy generation as part of the mix, with the aim of providing renewable energy to completely and independently power Garden Island, off the coast of Perth.

The $7.5 million project, with $2.5 million in support from the Australian Renewable Energy Agency (ARENA), will involve the construction and integration of 2 megawatts (MW) of photovoltaic solar capacity and a 2 MW/0.5 MWh battery storage system, coupled with Carnegie's CETO6 off-shore wave energy generation technology.

Construction will begin on Garden Island before the end of this year, and the project is expected to be operational by mid-2017.

Carnegie is an Australian wave energy technology developer that developed and owns the CETO Wave Energy technology, which converts ocean swell into zero-emission renewable power and desalinated freshwater. It is focused on commercial opportunities in key target markets including the UK, Europe and remote islands. Carnegie also owns 35 per cent of leading Australian battery/solar microgrid company Energy Made Clean, with which Carnegie has a strategic alliance agreement focused on delivering mixed renewable microgrid projects to islands, and remote and fringe off-grid communities.

Generating electricity with wave energy.

ARENA CEO Mr Ivor Frischknecht said the project represented the next generation of Carnegie's wave technology and was expected to demonstrate the viability of integrating a renewable-energy-based microgrid with a utility-scale distribution network.

"It will be the first time wave energy will be integrated into a microgrid, and if successful this diverse technology system could set a great new exportable opportunity for Australia to island nations around the globe," Mr Frischknecht said.

"With limited land available, wave energy generation supported by a reliable microgrid of battery storage and solar PV could be a better, cheaper and more sustainable way to power remote coastal or island communities long term, displacing their reliance on diesel fuel."

Carnegie's system is a small-scale power grid designed to operate independently or in conjunction with the Western Australian electricity network's main electrical grid, seamlessly transferring between the two modes: off-grid and island mode. The two modes of operation will demonstrate the system's future application for a range of fringe-of-grid and off-grid scenarios.

would answer some of the world's most pressing questions relating to sustainability, climate change and security," he said.

"This agreement is the mechanism through which Australians will be able to engage with ITER. In addition to ANSTO, Australian participants include ANU, the University of Sydney, Curtin University, the University of Newcastle, the University of Wollongong and Macquarie University."

It would clear the way for ANU's Australian Plasma Fusion Research Facility to install an Australian-developed plasma imaging system in the ITER reactor in France, he said.

A TOKAMAK IS THE KEY

Thousands of engineers and scientists have contributed to the design of ITER since the idea for an international joint experiment in fusion was first launched in 1985. ITER Members are engaged in a 35-year collaboration to build and operate the ITER experimental device, and bring fusion to the point where a demonstration fusion reactor can be designed.

Fusion energy is released by the merging of hydrogen into helium – the process that powers the Sun – and, if it could be safely harnessed on Earth, could provide clean, baseload power for millions of years. The Global Fusion Energy project centres on the construction of the world's largest tokamak, a magnetic fusion device or reactor, which harnesses the energy of fusion and captures this heat in the walls of the vessel. Like a conventional power plant, a fusion power plant would use this heat to produce steam and then electricity by way of turbines and generators, but with minimal greenhouse gas emissions and very low levels of radioactive waste.

The heart of a tokamak is its doughnut-shaped vacuum chamber where, under the influence of extreme heat and pressure, gaseous hydrogen fuel becomes a plasma – a hot, electrically charged gas that provides the environment in which light elements can fuse and yield energy.

First developed by Soviet research in the late 1960s, the tokamak has been adopted as the most promising configuration for a magnetic fusion device. The word 'tokamak' comes from a Russian acronym for 'toroidal chamber with magnetic coils'. ITER will be the world's largest tokamak – twice the size of the largest machine currently in operation, with 10 times the plasma chamber volume.

In the fusion process, air and impurities are first evacuated from the vacuum chamber. Next, the magnet systems that will help to confine and control the plasma are charged up and the gaseous fuel is introduced. As a powerful electrical current is run through the vessel, the gas breaks down electrically, becomes ionised (electrons are stripped from the nuclei) and forms a plasma. As the plasma particles become energised and collide they also begin to heat up. Auxiliary heating methods help to bring the plasma to fusion temperatures (between 150 and 300 million degrees Celsius). Particles 'energised' to such a degree can overcome their natural electromagnetic repulsion on collision to fuse, releasing huge amounts of energy.

NEWS

Inside the Murray-1 Hydro Power Station.

Snowy Mountains Scheme on National Heritage list

The Snowy Mountains Scheme has become the 107th place to be added to the National Heritage List – 15 major dams, nine power stations and a pumping station, covering a mountainous area of 4600 square kilometres in southern New South Wales.

Constructed between 1949 and 1974, the scheme is Australia's biggest industrial development, comprising 225 kilometres of tunnels, pipelines and aqueducts, with only two per cent of the entire construction visible above the ground.

The scheme's dams, tunnels, aqueducts and power stations are some of the most complex and technical engineering and construction feats in Australia and the world. Significant engineering advancements were achieved during the construction of the scheme, including rockbolting and the use of 330 kV transmission lines.

More than 100,000 people from about 30 countries worked on the Snowy Mountains Scheme.

Seventy per cent of these were migrants displaced from their homes in Europe during World War II.

The Snowy Mountains Scheme remains one of Australia's largest producers of renewable energy, including nearly a third of renewable energy fed into the eastern mainland grid, while water flowing from the scheme supports more than $3 billion of agricultural production.

NEW GRANTS TO INSPIRE STEM ENGAGEMENT

The Australian Government has announced grants of more than $13 million to help young Australians engage with science, technology, engineering and maths (STEM) opportunities.

The grants are aimed at providing more options for travel to national and international competitions and more opportunities to participate in the National Youth Science Forum and at the Asian Physics Olympiad, which Australia hosts in 2019.

The new Sponsorship Grants for Student Science Engagement and International Competitions includes funding of $6.4 million over four years for students under 18 to participate in science events, activities and competitions in Australia and overseas. Grants of up to $5000 per student and $20,000 per application are available, with matching contributions required for grants of more than $10,000.

These grants are available until the annual allocation is used up.

Funding of $2,992,000 over four years will enable Australian Science Innovations to deliver the Australian Science Olympiads and support some of our most talented science students participating in the International Science Olympiads.

A grant of $1,760,000 will support Australia's hosting of the 2019 Asian Physics Olympiad, the first time this event has been held here.

Funding of $1,496,000 over four years to the Australian Mathematics Trust will support student participation in the International Mathematics and Informatics Olympiads.

The National Youth Science Forum will use funding of $660,000 over four years to expand the National Science Teachers Summer School, start an additional January residential forum, hosting 200 students, and establish a fund to assist students from lower socio-economic and disadvantaged backgrounds to participate in activities.

FORTY YEARS AT CAPE GRIM

The Bureau of Meteorology's Cape Grim Air Pollution Baseline Station, located on Tasmania's remote north-west coast and one of the world's most important atmospheric monitoring sites, has marked 40 years of operation. Cape Grim provides a unique atmospheric record as it samples some of the cleanest air in the world, after it crosses the Southern Ocean from the tip of South America without passing over any other land mass. It provides the southern hemisphere's most comprehensive set of atmospheric greenhouse gas information, along with the measurements of ozone-depleting chemicals, solar radiation, reactive gases and basic meteorological components such as wind, air pressure and humidity.

Cape Grim is now globally recognised as one of only three premier World Meteorological Organization (WMO) global reference stations for the measurement of greenhouse gases, along with sites in Hawaii and Canada.

The BoM's Director, Dr Andrew Johnson FTSE, said long-term monitoring, measuring and analysis conducted at Cape Grim showed the world's atmosphere had changed.

"The information and data collected at the Cape Grim Station for the past 40 years has allowed scientists across Australia, and the world, to further understand our changing climate and strengthened our ability to track the progress of our response."

The BoM operates the Cape Grim facility and CSIRO analyses and models the data.

NEWS

PHOTO: CIMMYT

Wheat fields at CIMMYT's experimental station in northern Mexico.

CIMMYT looks to CSIRO

The International Maize and Wheat Improvement Center (known as CIMMYT by its Spanish acronym), the Mexico-based global leader in the development of high-yielding grain varieties and improved farming practices, is 50 years old.

The organisation is credited with catalysing the 'Green Revolution', which started in Mexico and improved crop yields and food security, preventing hundreds of millions of people from starving.

CIMMYT celebrated the milestone with a conference themed *Turning research into impact: past, present and future*, addressed by Dr Steve Hatfield-Dodds, who led CSIRO's integration science and modelling work and presented the 2015 Australian National Outlook, which is gaining international attention for its potential to improve food security in the developing world.

The first of its kind, the outlook linked nine national and global models to provide an integrated analysis of economic activity, agriculture and food, energy, water, land use, biodiversity, material flows and climate change.

"The aim of the outlook was to find and explore the ways Australia could navigate through interconnected future challenges, to better meet the needs of a growing national and global population," Dr Hatfield-Dodds said.

"These challenges are not unique to Australia, and CIMMYT can see how the flexible, integrated approach demonstrated by CSIRO can help identify and test options for reducing poverty and improving food security across diverse developing world contexts," he said.

CSIRO and CIMMYT have a long history of collaboration, particularly on the breeding of rust-resistant wheat varieties. CSIRO researchers have provided wheat breeders, both locally and internationally, with more than 20 genetic markers, helping the industry keep one step ahead of rust disease.

CIMMYT's work is estimated to provide at least $2 billion in annual benefits to farmers. More than 70 per cent of the wheat grown in developing countries and more than 50 per cent of improved maize varieties originate from CIMMYT.

AUSTRALIA AND CHINA LINK ON GRAINS RESEARCH

The Australia–China Joint Centre for Postharvest Grain Biosecurity and Quality Research – a partnership between Australia's Plant Biosecurity Cooperative Research Centre (CRC), Murdoch University and China's Academy of State Administration of Grain – has been inaugurated.

The Joint Centre will bring together leading researchers from China and Australia to work on developing non-chemical controls to manage stored grain pests with the aim of reducing biosecurity and trade risks while providing clean grain.

It will focus on innovative technologies such as the use of nitrogen for stored grain pest management and 'lure-and-kill' pest control using pheromones and light-based trapping systems. The partnership will work with grain suppliers and companies to commercialise the research and deliver it to industry.

The Joint Centre's grains research laboratory is led by Professor YongLin Ren, a world leader in postharvest grains research.

With grain Australia's most significant agricultural export and China the world's largest producer of wheat, the two countries share similar industry challenges.

"Global grain markets are changing and we need to change with them. Established methods for stored grain pest control are facing increased pressure from both regulation and changing market preferences for non-chemical options," said Dr Michael Robinson, CEO of the Plant Biosecurity CRC.

NEW MACQUARIE ISLAND RESEARCH STATION

Australia's science and research capacity will be boosted with a Government commitment to build a new $50 million research station on Macquarie Island.

This significant investment is in addition to the $2.2 billion the Government is already investing to support its landmark Australian Antarctic Strategy and 20-Year Action Plan.

The Government says the year-round station will be the most advanced of its type in the Southern Ocean. Macquarie Island is an important global monitoring location for scientific research, including monitoring southern hemisphere weather and climatic data.

It will support the work of the Bureau of Meteorology, Geoscience Australia and the Australian Radiation Protection and Nuclear Safety Agency.

The existing station, which is reaching the end of its life, will be decommissioned and the old buildings removed over the next decade. Permanent operations will be maintained in the lead up to the new station being fully operational by 2021-22.

BY IAN RAE
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The expert handbook on ground engineering

BOOK REVIEW

Ground engineering: principles and practices for underground coal mining by J.M. Galvin, xxiii + 684 pp, $129.00

Environmental conflict over the development of new mines keeps open-cast mining in the public eye so it's easy to forget that underground mining still plays an important part in the industry.

Australia produced about 400 million tonnes of black coal in 2012-13 (the latest figures available to me), 80 per cent of which came from open-cut mines, mostly located in Queensland and New South Wales. The remaining 20 per cent is still a large figure, which helps to explain why the Australian Coal Research Association and the Minerals Council of Australia should commission a handbook on ground engineering and risk management in the underground coal mining industry.

To prepare the handbook they turned to Dr Jim Galvin FTSE, a mining engineer with specialist knowledge in rock mechanics and risk management built on the basis of an extensive career in South Africa and Australia. Dr Galvin has done them proud: it's a great book, available in hardback or online.

Each of the 12 chapters begins with an abstract and a list of keywords, and ends with a reference list. In the early, more fundamental chapters the references are to books and scholarly articles but in the more advanced sections they are more frequently to conference papers.

There are 18 appendices covering everything from key developments in the history of ground engineering and calculations of rock deflections to guidelines for mine safety management systems. There is an excellent index (14 pages), a glossary of

CATHAY STARTS WEEKLY TOOWOOMBA SERVICE

Cathay Pacific has commenced weekly international freight services through Brisbane West Wellcamp Airport, at Toowoomba, reducing transit times and costs for trade-focused businesses in Toowoomba and the surrounding region. It will become the first dedicated international freighter service to Brisbane West Wellcamp and will operate on a Hong Kong–Sydney–Melbourne–Brisbane West Wellcamp–Hong Kong routing every Monday, using Cathay Pacific's newest and biggest freighter, the Boeing 747-8F, on the route, following a successful trial flight to Brisbane West Wellcamp Airport last year.

The Boeing 747-8F aircraft offers more cargo space to carry the anticipated high volumes of fresh produce from one of Australia's most productive agricultural regions, as well as machinery for mining projects and manufacturing in the region.

The service will meet growing demand to move a wide range of commodities from southern Queensland and its catchment area to key markets in Asia, Europe and North America, providing shippers with greater choice and flexibility when connecting to Cathay Pacific's international cargo network through the Hong Kong hub.

PHOTO: LENN BAYLISS

The first Cathay Pacific freighter at Wellcamp.

REFUEL WINS $47 MILLION FUEL TANKER CONTRACT

Melbourne company Refuel International has won a $47 million contract to build the Australian Defence Force's new aviation fuel tankers. The new fleet will allow the Australian Defence Force to retire its current ageing fleet of refuelling vehicles, enabling it to efficiently and effectively refuel and defuel its current and future fleets of fixed-wing aircraft and helicopters across its Australian bases and at Butterworth, in Malaysia.

Defence Industry Minister Christopher Pyne said the contract would create more than 60 direct jobs at Refuel International, which had a long history in Australia and global experience in the manufacture of aviation refuelling vehicles.

NEWS

symbols and a glossary of terms, the latter being essential reading for those unfamiliar with the language of the profession in which terms like 'boot-end', 'goaf' (aka 'gob'), 'inbye/outbye' and 'pot arse' (yes, really) are used.

"Ground engineering" – a title adopted after consideration of others in everyday use – "is concerned with the design, construction, operation, maintenance and, ultimately, the closure of safe, serviceable, durable, environmentally sustainable" mines.

Dr Galvin doesn't deal with starting a mine: he concentrates on working mines. The first part of the book deals with rock mechanics and material properties. A Young's Modulus table reminds us of the great difference in strength of the coal (2 to 4 GPa), surrounding sandstone and conglomerate (6 to 30 and 20 to 40, respectively). Timber isn't mentioned but there is an extensive discussion of its use, and some dramatic photographs, further into the handbook.

Ground support and reinforcement systems, including a number of pillar designs, are at the core of the handbook and the relevant text is illustrated with diagrams and photographs. Coal is not uniform from mine to mine and Dr Galvin provides guidance on appropriate choices.

There is, of course, an extensive discussion of long-wall mining techniques, which now dominate the industry.

There is a section on the operational hazards of underground mining, and finally the assessment and management of risk. Obviously drawing on long experience, Dr Galvin warns of the dangers of taking risk advice without the most rigorous checking of the basis for that advice. Referring to generic advice from IEAust (*Are You at Risk?* 1990) he writes that "engineers project an image of dealing in 'hard' models, whereas in the main they deal with 'soft' models".

"Engineers do not really solve problems," he writes, but rather they choose between options in the face of considerable uncertainty.

The book is splendidly illustrated with presentations of quantitative data, mine plans and photographs of some of the untoward things that can happen in underground mines. In places, the author goes to extraordinary length to the identify problems and provide technical explanations.

I have chosen one for comment, and it concerns stress corrosion cracking of rock bolts. The high-tensile steel bolts are always under strain – that's what they are there for – but in a number of instances there is slow progressive crack growth and this has been found to correlate with data (Charpy impact values) characterising the ductile-brittle transition of the material. Using steel with much higher Charpy values solved this problem, but did not deal with the related problem of hydrogen embrittlement and consequent stress cracking. Hydrogen embrittlement of steels is well known when hydrogen gas is being stored, but where does the hydrogen come from in a coal mine? The answer seems to be from the water and reducing bacteria that are also known to convert dissolved sulfate to hydrogen sulfide.

Since, worldwide, 60 per cent of black coal is won from underground mines rather than open cuts, *Ground engineering* should attract international sales and help mine operators to achieve optimum mining efficiency without compromising safety. ⊙

Professor Ian Rae FTSE, an Honorary Professional Fellow at the University of Melbourne, is a former technical Director of ATSE. He was President of the Royal Australian Chemical Institute (2006–08) and served for a decade as a technical adviser to the UN Environment Programme. He is co-editor of the Australian Academy of Science journal Historical Records of Australian Science.

NEW TOXIC CHEMICAL FILTER FOR TROOPS

The Department of Defence and CSIRO have signed a $3.2 million agreement to produce a production-ready prototype new respirator filter for the Australian Defence Force (ADF) to protect troops from chemical, biological and radiological threats.

CSIRO has been working with Defence since February 2016 to develop a prototype filter that would meet the ADF's capability needs for respiratory protection using an innovative nanotechnology that provides enhanced protection against toxic industrial chemicals and the project has successfully completed the proof-of-concept phase.

CSIRO will develop the Metal Organic Frameworks technology into a filter canister for use with the in-service respirator.

An artist's impression of the new vessel.

INCAT FERRY FOR MALTA

Tasmanian international shipbuilder Incat has contracted with Virtu Ferries of Malta to design and build a 110-metre vehicle passenger ferry, which will be the largest high-speed catamaran in the Mediterranean.

The wave-piercing catamaran will become the 15th fast ferry Virtu has acquired. With a service speed up to 38 knots it will complete the crossing from Malta to Sicily in about 90 minutes.

It will provide a significant increase in capacity for Virtu Ferries, offering 43 per cent more truck capacity, 15 per cent more passenger capacity and seven per cent more car capacity. The vessel will incorporate a three-class interior (VIP, business and economy), with a total of 1134 seats (996 inside and 138 outdoors).

Construction of the vessel will start in early 2017 with delivery scheduled at the end of 2018. Incat currently has a 500-strong workforce at its Hobart shipyard and the yard is geared for delivering up to two large high speed craft per year.

Virtu Ferries has been operating high-speed ferries for 28 years and operates services between Malta and Sicily, Venice and Croatia and Slovenia, and Tarifa (Spain) and Tangier (Morocco).

NEWS

China National GeneBank launches new era

The China National GeneBank, a nonprofit research institute founded by the Chinese Government and the Chinese-based BGI, one of the world's premier genome sequencing centres, has been launched in China.

It plans to be one of the world's most comprehensive and sophisticated biorepositories, with breakthroughs in human healthcare, biodiversity and agriculture.

The CNGB, in Shenzhen, is a 47,500 m^2 facility comprising a Biorepository, Bioinformatics Data Centre, Living Biobank, Digitalisation Platform, and Synthesis and Editing Platform.

Australian researchers will be able to tap into the CNGB's resources through their collaborations with BGI, formerly known as the Beijing Genomics Institute, which recently established its Asia–Pacific headquarters in Brisbane, and is currently undertaking a number of Australian research collaborations with CSIRO, the University of Melbourne, the University of Queensland, James Cook University, Griffith University, the Australian Museum, Museum Victoria and the Australian Department of Agriculture, Fisheries and Forestry.

BGI President and co-founder Professor Jian Wang said the CNGB would forge new discoveries in life sciences by creating a research network to foster global collaboration and communication, and to promote innovation in the community.

"Stockpiling the planet's biodiversity in genebanks for the future is one of the most important and essential endeavours today's scientists can pursue," he said.

CNGB Associate Director and Senior Scientist Dr Guojie Zhang said the new genebank would strengthen the close and broad collaborations that BGI had established with Australian scientists during the past 17 years.

"The University of Sydney is looking forward to growing our partnership with BGI and the CNGB over the coming years," said University of Sydney Pro-Vice Chancellor (Global Engagement) Professor Katherine Belov.

BGI is one of the world's largest genomic organisations. It was founded in 1999, and today has established 47 laboratories worldwide and employs more than 5000 people. Apart from contributing to international projects such as the Human Genome Project and the 1000 Genomes Project, BGI was the first in the world to sequence the genomes of key plants (such as rice, sorghum and millet), animals (such as the giant panda, silkworm and polar bear), bacteria and viruses.

Entrance of the new China National GeneBank.

AN INNOVATION SAVING AUSTRALIA BILLIONS

Global stock markets are fairer and more efficient thanks to the work of Professor Michael Aitken, winner of the 2016 Prime Minister's Prize for Innovation for creating and commercialising tools that are making markets fair and efficient.

Professor Aitken is CEO and Chief Scientist with the Capital Markets Cooperative Research Centre and Professor of ICT Strategy at Macquarie University.

On founding Capital Markets CRC, he developed SMARTS, a real-time surveillance software that services regulators, exchanges and brokers of capital markets. In Europe, this surveillance solution has helped to reduce instances of insider trading by 26 per cent. SMARTS has been adopted by more than 40 national exchanges and regulators and 150 brokers across 50 countries.

SMARTS was then sold to NASDAQ in the US, with a significant proportion of the proceeds used to fund a venture firm now funding technology start-ups and research scholarships in Australia.

Another of the Capital Markets CRC's spin-off companies, Lorica Health, is now using software-based surveillance to detect fraud, abuse, waste and errors in Australia's mammoth and fragmented health sector. Early indications are that there are savings worth billions of dollars per year that could be made, and then directed to areas of service that would deliver huge health dividends to the country.

Michael Aitken

The efforts of the Capital Markets CRC have created an ecosystem of companies that provide 200 permanent jobs and contribute $6 million in tax revenues each year.

Professor Aitken has also established an expert witness service whereby doctoral candidates work on real-world legal cases involving allegations of insider trading and market manipulation.

"What really excites me about my work is the work I do with PhD students – 130 of them – they will be the new round of innovators, they'll take innovation to the world," he says.

• Professor Graeme Jameson AO FREng FAA FTSE, from the University of Newcastle, won the 2015 Prime Minister's Prize for Innovation.

ATSE PEOPLE

Michelle Simmons wins world L'Oréal award

Professor Michelle Simmons FAA FTSE has been honoured with a €100,000 international L'Oréal-UNESCO For Women in Science Award for her pioneering research in quantum physics.

Professor Simmons, Director of the ARC Centre of Excellence for Quantum Computation and Communication Technology (CQC^{2}T) at the University of NSW, is one of five eminent female researchers from around the world named as 2017 L'Oréal UNESCO laureates in the Physical Sciences.

She is the winner of the Asia–Pacific region "for her pioneering contributions to quantum and atomic electronics, constructing atomic transistors en route to quantum computers".

The five women, representing Africa and the Arab States, Asia–Pacific, Europe, Latin America and North America, will receive their awards and prize money worth $146,000 at a ceremony to be held in Paris in March next year.

Professor Simmons' team is the only one in the world that can make atomically precise devices in silicon. They have produced the world's first single-atom transistor as well as the narrowest conducting wires ever made in silicon, just four atoms of phosphorus wide and one atom high.

"Trying to control nature at its very smallest scale is such an exciting and rewarding field to be in," she said. "This has been my passion for many years and has such tremendous potential. I am honoured by this recognition and hope it inspires others."

As director of CQC^{2}T, she heads a team of more than 180 researchers across six Australian universities, including UNSW. Centre scientists and engineers are leading the international race to build the world's first quantum computer in silicon, and hope to produce a 10-qubit circuit within five years.

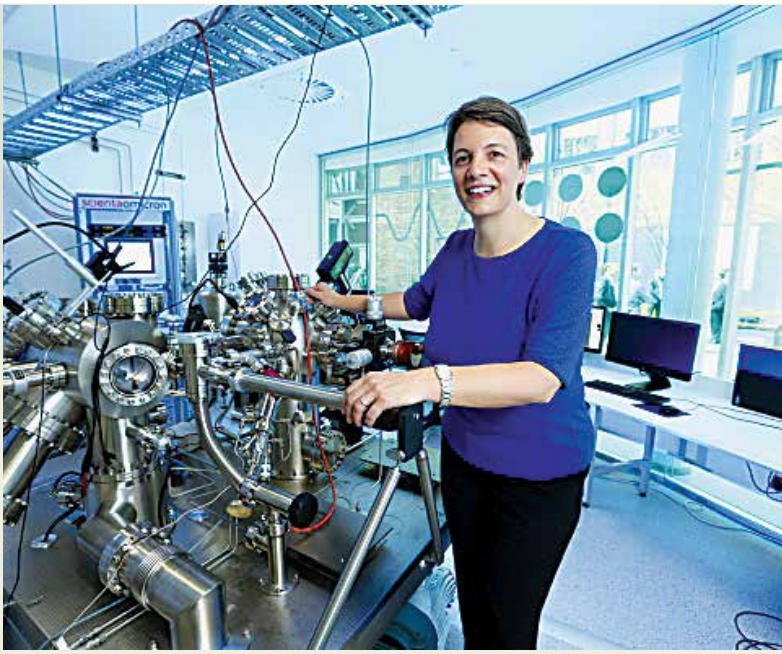


PHOTO: BRITTA CAMPION/NEWS CORP

Michelle Simmons

In 2014 she had the rare distinction for an Australian researcher of becoming an elected member of the American Academy of Arts and Sciences.

Through its For Women in Science program, the L'Oréal Foundation, in partnership with the United Nations Educational Scientific and Cultural Organization (UNESCO), supports women researchers and rewards excellence in scientific fields where women remain under-represented.

The five 2017 L'Oréal-UNESCO international laureates were selected from international nominees by an independent international jury of 12 prominent scientists presided over by Professor Christian Amatore, a member of the French Academy of Sciences.

KEVIN GALVIN NAMED IN NSW SCIENCE PRIZES

Professor Kevin Galvin FTSE, a former Clunies Ross Award winner (2014), has been named winner of the Energy Innovation in NSW Category in the 2016 NSW Premier's Awards for Science and Engineering.

Professor Rick Shine AM FAA, Professor of Biology at the University of Sydney, was named 2016 NSW Scientist of the Year.

Laureate Professor Galvin is the Director of the Centre for Advanced Particle Processing and Transport, and Director of the ARC Research Hub for Advanced Technologies for Australian Iron Ore at the University of Newcastle.

He is recognised for his innovations in minerals processing research through his inventions and development of the Reflux Classifier and related technologies, including the Reflux Flotation Cell and the Graviton.

These technologies came from laboratory-scale studies within the University of Newcastle, and major research collaborations with industry via pilot and full-scale plant trials, the largest of which is currently underway in the Hunter Valley.

His work led to the establishment of a new 'laminar shear separation mechanism', which has revolutionised gravity separation, leading to the adoption of the Reflux Classifier technology around the world, via more than 100 full-scale installations.

LUNCH WITH MELBOURNE'S CAMBRIDGE SOCIETY

Victorian Division Fellows attended a joint lunch meeting with members of the Cambridge Society in October to hear Professor David Andrewes, from the University of Melbourne's School of Psychological Sciences, discuss *The curious brain relationship between intention, action and culpability*.

His presentation included the neuropsychological evidence that describes the nature of the relationship between actions and their apparent conscious initiation and how these features may interact in an individual with reduced emotional control – leading to discussion of tailored rehabilitation requirements for the violent offender.

ATSE PEOPLE

Catherine Livingstone to chair CBA

Catherine Livingstone

Ms Catherine Livingstone AO FAA FTSE, President of the Business Council of Australia, has been appointed Chairman of the Commonwealth Bank of Australia from 1 January 2017, replacing Mr David Turner.

She has been a non-executive director of CBA since March 2016. She was formerly Chairman of Telstra Corporation and Chief Executive Officer of Cochlear.

She retired as President of the Business Council of Australia in November.

Mr Turner said: "Catherine's strong business experience, complemented by her interest in technology and innovation, will mean she will be an excellent and well-qualified Chairman."

Ms Livingstone is a respected company director with extensive business and finance experience across a broad range of industries and organisations. She is also a Chartered Accountant.

Her executive career spanned more than 22 years in which she held general management and finance leadership roles, primarily in the medical devices sector and including six years as the Chief Executive Officer of Cochlear Ltd.

Ms Livingstone is a former Chairman of Telstra Corporation Ltd and of CSIRO. She has served on the Boards of Macquarie Group Ltd, Goodman Fielder Ltd and Rural Press Ltd and has contributed to the work of the Innovation and Productivity Council for the New South Wales Government.

Other directorships and interests include WorleyParsons Ltd, The George Institute for Global Health, Saluda Medical Pty Ltd and Australian Museum Trust (President).

LEN SCIACCA MOVES TO ENTERPRISE ROLE

Professor Dr Len Sciacca FTSE, previously Chief of Partnerships and Engagement at Defence Science and Technology, has taken up the role of Enterprise Professor at The University of Melbourne in the area of defence research and engagement.

In this role he will work across the university helping to establish and support increased engagement between academics, defence research and industry.

The university established Enterprise Professors in 2015 to bring to the university capabilities and expertise that would increase the intensity and depth of industry engagement amongst academics.

Professor Sciacca has a PhD in electrical engineering in the area of industrial signal processing and control from the University of Newcastle and more than 30 years' experience in research and development, research leadership and engineering research in both small and large industry, CSIRO, defence science and technology and academia.

In the 1990s he and other academics from the University of Newcastle founded a start-up company in satellite tracking and the design of large telecommunications and radio-astronomy antenna control systems. He has extensive and deep understanding and know-how in industry–university engagement.

Professor Sciacca was the inaugural Director of the Defence Science Institute along with the Research Director Professor Bill Moran.

The Defence Science Institute was originally established as a joint venture between DST, The University of Melbourne and the Victorian Government. It is now recognised as a world-class research facilitation organisation that works closely with all Victorian universities and DST to foster partnerships and collaboration between universities and industry across Australia.

At DST, Professor Sciacca held several roles including Chief of Electronic Warfare and Radar Division, Chief Operating Officer and recently Chief Partnerships and Engagement, leading DST's international and national partnerships as well as science communications and STEM outreach.

Len Sciacca

The increased engagement by DST with the Australian research community was led by the Chief Defence Scientist, Dr Alex Zelinsky FTSE. Professor Sciacca and his partnerships team established the Defence Science Partnership program, which now has more than 30 universities working with Defence using a common agreement and intellectual property framework.

Professor Sciacca has a passion for seeing research implemented in real systems.

"Most of my career has been working at the interface of research and the development of products and systems.

"I believe I can make my best contribution to Australia by facilitating industry–university engagement, translating industry needs into research programs and helping to form and guide the multidisciplinary teams to realise impactful outcomes."

ATSE PEOPLE

Graeme Jameson honoured in Quebec

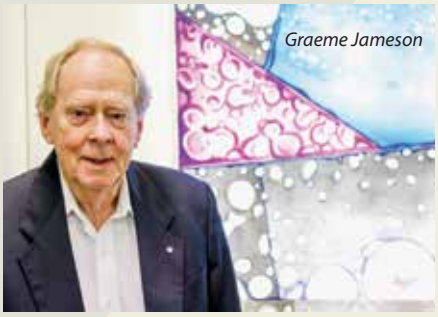


PHOTO: UNIVERSITY OF NEWCASTLE

Professor Graeme Jameson AO FREng FAA FTSE has been honoured by the International Mineral Processing Congress (IMPC) with a Lifetime Achievement Award.

Presented at the IMPC 2016 Conference in Quebec, Canada, the Award recognises a lifetime of distinguished achievement and outstanding contribution to the art, science and industrial practice of mineral processing.

The first IMPC meeting was held in London in 1960. In the 56 years since, the Lifetime Achievement Award has been granted only 10 times. Professor Jameson shared the 2016 honour with Professor Ponisseril Somasundaran from the US.

The Award was presented before an audience of 1500 academic and industry specialists, at the XXVIII meeting of the Congress.

This award joins a long list of accolades for Professor Jameson's work including the 2015 Prime Minister's Prize for Innovation.

Professor Jameson, a stalwart of the University of Newcastle, has made a major contribution to the Australian economy and the environment as inventor of the Jameson Cell – used for copper, coal, zinc, nickel, lead, silver and platinum extraction worldwide.

More than 300 Jameson Cells are now in operation across 25 countries, with the invention estimated to have earned nearly $100 billion for the Australian economy.

ROB FITZPATRICK WINS INTERNATIONAL AWARD

Rob Fitzpatrick

Professor Rob Fitzpatrick FTSE, Director of the Centre for Australian Forensic Soil Science (CSIRO) and the Acid Sulfate Soils Centre (University of Adelaide), has been recognised internationally.

He won the inaugural award for outstanding international contributions to Forensic Geology and Forensic Soil Science by the International Union of Geological Sciences (IUGS) Initiative on Forensic Geology.

The award was recently presented to him during the 35th International Geological Conference in South Africa at the Symposium on Forensic Soil Science and Geology jointly held with the 5th International Conference on Criminal & Environmental Soil Forensics where he presented a keynote paper titled 'The importance of geological and soil materials as trace evidence in solving criminal investigations in Australia'.

Professor Fitzpatrick, a Fellow since 2008, has an encyclopaedic knowledge of the distribution, characteristics, development and protection of Australian and overseas soils. His research has influenced natural resource management, engineers, mining industries and the justice system.

His work in three fields has been acknowledged as a national benefit. He is a consultant to Telstra on the impact of soils on the stability of fibre optic cables. His knowledge on acid sulfate soils in coastal and inland systems, especially in River Murray environments, is being applied to solve environmental problems. He developed the concept of 'forensic soil science', together with Flinders University, and used clay mineralogy to solve scores of crimes.

PILLING HEADS SWINBURNE GROUP

Mr Ross Pilling FTSE, former Chairman and Managing Director, BASF Australia and New Zealand, and former Deputy National President, Ai Group, has been appointed inaugural chair of a new Industry Research Advisory Committee at Swinburne University.

The committee will guide the university's research and innovation strategy and focus on matters relating to specific sectors, opportunities and trends such as: future industries; regional developments; innovation and technology; policy; research agenda; research training; and market intelligence.

The committee comprises leaders from industry, government and business in Australia and throughout the region and includes Dr Anita Hill FTSE, Executive Director, Future Industries, CSIRO, and Victoria's Lead Scientist, Dr Amanda Caples.

Swinburne says Mr Pilling brings a wealth of multinational industry experience across a diversity of sectors including manufacturing, agriculture, chemicals and polymers, construction, mining, personal care, home care, health and nutrition.

"This initiative is critical to achieving our research with impact agenda in line with our Research and Innovation Strategy 2020," says Swinburne Deputy Vice-Chancellor (Research and Development) Professor Aleksandar Subic.

Five new research institutes will spearhead Swinburne's research engagement. They will bring together expertise in data science, health innovation, smart cities, social innovation and manufacturing futures to solve significant real-world problems in partnership with industry, business and community.

"Our institutes will benefit greatly from the strategic advice and guidance of the new industry research advisory committee," Professor Subic says.

Ross Pilling received an honorary doctorate from Swinburne in August.

ATSE PEOPLE

New ATSE Fellows include seven women

The Academy has elected 25 new Fellows for 2016, including key business leaders and academics, prominent commercial innovators, professional and business leaders and respected public sector figures.

The new Fellows include seven prominent women – almost achieving the Academy's target of electing one-third of its new Fellows from female candidates.

They come from a wide array of sectors and specialisations, including agriculture, bionic vision, biotechnology, cyber security, defence, engineering, geotechnics, ICT, manufacturing, medical research, neurosurgery, photovoltaics, resources, robotics, shipbuilding, structural dynamics and water.

The Academy has recognised the special role of General David Hurley, former Chief of Defence and now Governor of NSW, in the promotion of science and technology by electing him an Honorary Fellow, an honour not bestowed since 2006, when the Academy elected his predecessor, Dame Marie Bashir, and former House of Representatives Speaker Neil Andrew as Honorary Fellows.

The Academy has additionally elected a Foreign Fellow: Professor Robin Grimes, Chief Scientific Adviser to the UK Foreign and Commonwealth Office.

Eight Fellows are from NSW, five from Victoria, four from WA, three each from Queensland and SA, and two from the ACT.

They include the WA Chief Scientist, Professor Peter Klinken; CSIRO's CEO, Dr Larry Marshall; Australian Meat & Livestock Chair, Dr Michelle Allan; Textor Chair, Mr Phillip Butler; and Geoscience Australia CEO, Dr Christopher Pigram.

All are leaders in their fields.

2016 FELLOWS

DR MICHELE ALLAN FTSE

Chair, Meat & Livestock Australia (Victoria)

Dr Allan's outstanding achievements arise from her ability to lead commercially successful technology-based organisations within the rural sector. She is a food industry and agribusiness specialist with academic credentials in biomedical science, technology management and commercial law. Dr Allan complements this background with her exceptional ability for strategic leadership in complex organisations.

PROFESSOR SIMON BIGGS FREng FTSE

Executive Dean, University of Queensland (Queensland)

Professor Biggs is internationally acclaimed for his research in particle, colloid and interface engineering. Prestigious awards and applications of his cutting edge technologies attest to his impact on industries in the chemical, minerals and nuclear sectors. He is skilled in the processes of innovation and engagement with end users, and is championing the offering of entrepreneurship and innovation experiences to engineering, science and ICT students. He is a national leader in commitment to inspiring female engineering students.

MR PHILLIP BUTLER FTSE

Owner and Chairman, Textor Technologies (Victoria)

Mr Butler is recognised for his national leadership in SME manufacturing, having transformed Textor into textile company manufacturing components for diapers, femcare and incontinence products and becoming a global exporter to 18 countries. He is an advocate for all innovation-ready Australian manufacturers via mentoring and leadership across industry, industry associations, and state and Federal government initiatives.

DR STUART CANNON FTSE

Research Leader, Defence Science and Technology Group (Victoria)

Dr Cannon is a world-leading naval architect transforming naval ship building and safety nationally and internationally. He is the Royal Australian Navy's trusted advisor on warship technology and approaches to improve the performance of warships and submarines, to ensure their safety and cost effectiveness. He has deployed theoretical knowledge and hands-on experience in naval architecture, structural engineering and systems analysis to solve challenging naval architectural problems.

DR JACQUELINE CRAIG FTSE

Former Chief of Cyber Electronic Warfare Division, Defence Science and Technology Group (SA)

In a career exceeding 20 years, Dr Craig has led the applied research effort of local and global defence and intelligence communities to create cutting-edge capability for Australia's defence and national security. Her contribution spans digital imagery data collection and exploitation, space and unmanned systems, electronic warfare, and cyber security and operations. Defence and industry projects of great national importance have relied on her research and leadership.

ATSE PEOPLE

DR DIMITY DORNAN AO FTSE

Executive Director and Founder, Hear and Say (Queensland)

Dr Dornan is a speech pathologist and the founder, former Clinical Director and now Executive Director of Hear and Say, which enables deaf children to listen and speak by optimising the application of technology such as cochlear implants. She is a tireless campaigner to improve the hearing outcomes of deaf children and actively contributes through her clinical and research work. She is recognised nationally and internationally for the impact of her work.

DR EILEEN DOYLE FTSE

Non-Executive Director, Boral, GPT and others (NSW)

Dr Doyle is an esteemed business leader who has built her career primarily in industrial companies drawing on a foundation of a doctorate in mathematics/statistics. She is actively engaged in promoting technological innovation in the companies in which she is involved. She has played a key role in governance of research institutions. She has been a business angel for many years and is committed to the economic and social development of NSW's Hunter Region.

PROFESSOR ABIGAIL ELIZUR FTSE

Professor, Aquaculture Biotechnology, University of the Sunshine Coast (Queensland)

Professor Elizur has applied advanced science and technology to the aquaculture industry to secure sustainable production and tackle the issues surrounding reproduction in captivity, which is a major bottleneck in the domestication of aquaculture species. She has been involved in varied projects from spawning the southern bluefin tuna – a world first for this endangered species – to controlled spawning of the pearl oyster, enabling precise management of mating, a key to implementation of genetic programs.

DR JACKIE FAIRLEY FTSE

CEO and President, Starpharma Holdings Limited (Victoria)

Dr Fairley is the Chief Executive Officer of Starpharma, an Australian-based, ASX300-listed biotechnology company, which is a world leader in the development of dendrimer (a type of synthetic molecule) products. For the past decade, she has led the company as it has developed and commercialised its products. She is a member of the Commonwealth Science Council and a leading spokesperson for the pharmaceutical and biotechnology industries.

PROFESSOR BARNEY GLOVER FTSE

Vice-Chancellor, Western Sydney University (NSW)

Over 20 years Professor Glover has initiated and nurtured major projects linking academia to industry and end users. These projects have directly impacted technological sciences and engineering and innovation, fostered collaboration and driven local economic development. As vice-chancellor of two universities he has championed STEM education, particularly for Indigenous and disadvantaged students. Currently, as Chair of Universities Australia, he has contributed significantly to the innovation debate and is leading UA's policy response.

PROFESSOR HONG HAO FTSE

Faculty of Science and Engineering, Curtin University (WA)

Professor Hao has made ground-breaking contributions to the advancement of knowledge and practice of structural dynamics. His results have been included in design codes and textbooks, and applied in engineering practice worldwide, providing safe and robust civil infrastructure against natural and man-made dynamic loads. His strong international standing is evident in his publications and his leadership positions in professional committees and services to many government agencies and industrial organisations globally.

DR THOMAS HATTON PSM FTSE

Chairman, Environmental Protection Authority (WA)

Dr Hatton is known for his significant individual contributions to the development of technologies and their application to natural resource management, and outstanding leadership in the development of water, marine and energy technologies and their application to management and influence on public policy. He chairs the Environmental Protection Authority of WA. He is an adjunct professor at the University of Western Australia and a former member of the CSIRO Group Executive.

PROFESSOR TONY HAYMET FTSE

Scripps Institution of Oceanography, University of California San Diego (NSW)

Professor Haymet, a former Chief of Marine and Atmospheric Science at CSIRO, is Director of the Scripps Institution of Oceanography in San Diego. His leadership at CSIRO and Scripps focused on building marine and climate science capability, initiating globally significant collaborations, and strengthening national and global research partnerships. He co-founded Australia's Integrated Marine Observing System, the Western Australian Marine Science Institution, CSIRO's Wealth from Oceans Flagship, and the Quantitative Marine Science Program with the University of Tasmania.

ATSE PEOPLE

PROFESSOR GERNOT HEISER FTSE

John Lions Chair of Operating Systems, School of Computer Science and Engineering, University of NSW (NSW)

Professor Heiser is a pioneer in the development of formally verified secure computer operating systems, which underpin the protection of computer systems from cyber attack and the development of dependable systems in applications from robotics to medical devices. He led the team that developed the mathematics to allow large-scale verification of operating systems, developed the first secure microkernel, and led its deployment in defence robotics systems. He was a founder of Open Kernel Labs in 2006, which was sold to General Dynamics in 2012.

PROFESSOR SVEND PETER KLINKEN FTSE

Chief Scientist, Government of Western Australia (WA)

Professor Peter Klinken is an outstanding medical scientist with many publications in leading international journals. His work has led to the granting of several current patents relating to tumour suppression, sumoylation control, transcription modulation and hormone disorders. He has led the establishment of the WA Medical Research Institute. In 2008 he was named WA Citizen of the Year and in 2014 he was appointed Chief Scientist for Western Australia, in which role he has displayed great leadership in developing science policy.

PROFESSOR PETER LANGRIDGE FTSE

Emeritus Professor, University of Adelaide (SA)

Professor Langridge's research on molecular genetics has been translated into breeding technologies that are widely applied in public and private cereal-crop-improvement programs around the world. He has published six patents and more than 280 papers in refereed international journals. His papers have been cited more than 15,000 times. The impact of his work has been recognised through invitations to join editorial boards, to speak at scientific meetings, and to join many international science advisory committees, review panels and boards.

DR LARRY MARSHALL FTSE

Chief Executive, CSIRO (ACT)

Dr Marshall has a passion for translating science and technology into products and value. He has more than 25 years' experience in the US commercialising his laser inventions into nine successful products and then using his experience to develop a venture capital firm. Since becoming the Chief Executive of CSIRO in 2015 Dr Marshall has positioned it as Australia's innovation catalyst and provided influential input to the Government's National Innovation and Science Agenda, including establishing the $200 million CSIRO Innovation Fund to co-invest in spin-offs and start-ups from publicly funded research agencies and universities.

PROFESSOR EDUARDO NEBOT FTSE

Director, Australian Centre for Field Robotics, University of Sydney (NSW)

Professor Nebot is a pioneer in the development and application of navigation and automation technology for robotics. He is recognised for developing key ideas in high integrity navigation, localisation and mapping, safety systems, and the development of automation systems for mining and automotive industries. He has a leading record working with companies and government organisations in applying and commercialising these technologies, and introduced new mining safety technology that has been deployed in mines around the world.

DR CECILE PARIS FTSE

Senior Principal Research Scientist and Group Leader, CSIRO (NSW)

Dr Paris has translated deep knowledge in computer science to solving real-life problems in the social sciences. She has developed an understanding of how people communicate, how they interact within information environments and how they make sense of big data. This has major impacts in social science and the digital economy. One application developed by Dr Paris and her team is enabling government departments to monitor views of the services provided. Another is helping emergency services to use social media messages to identify unexpected events and unfolding disasters.

DR CHRISTOPHER PIGRAM FTSE

Chief Executive Officer, Geoscience Australia (ACT)

Dr Pigram has made an outstanding contribution to a range of national strategic issues through his leadership in the field of geoscience, including major achievements in marine geoscience, minerals and energy exploration, groundwater management and natural hazards. This work has included a major contribution to the evidence base for Australia's Marine Jurisdictional claim at the United Nations. He has an extensive knowledge and experience of Australian geology and the use of science in support of wide-scale policy development.

PROFESSOR IAN REID FTSE

Professor of Computer Science, University of Adelaide (SA)

Professor Reid is deputy director of the Australian Centre for Robotic Vision. He

ATSE PEOPLE

has substantially shaped the world of robot navigation, using computer vision techniques to map a robot's environment so that it can operate autonomously in complex, urban situations. His work has been acknowledged as outstanding with the award of an ARC Laureate Fellowship. He has patented and translated his ideas into practical applications, guiding industry in manufacturing, solving referee issues in sport, and contributing to the analysis of historical art.

MAJOR GENERAL PROFESSOR JEFFREY V. ROSENFELD AM OBE KSTJ FTSE

Director, Monash Institute of Medical Engineering, Monash University (Victoria)

Professor Rosenfeld is a leader in neurosurgery, surgical research and the impact of engineering on neuroscience and medicine. He was Foundation Director of the Monash Institute of Medical Engineering, which is focused on the development, translation and commercialisation of innovative health technology. His work with interdisciplinary researchers, industry participants and community groups delivers innovations that include bionic vision, advances in brain computer interfaces with direct brain electrical stimulation, and trauma treatment. He is a Major General in the Australian Defence Force.

PROFESSOR THORSTEN TRUPKE FTSE

School of Photovoltaic and Renewable Energy Engineering, University of NSW (NSW)

Professor Trupke has made outstanding contributions to the field of photovoltaics (PV) and solar cell technology through his pioneering research breakthroughs and their subsequent translation to industry. In particular, his photoluminescence (PL) imaging (commercialised via BT Imaging, of which he was a co-founder and is the CTO) has been revolutionary, with PL now a standard method used in virtually all PV research laboratories. It has been central to the significant acceleration in PV R&D.

DR IAN TYLER FTSE

Assistant Director Geoscience Mapping, Geological Survey of Western Australia (WA)

Geological, geochemical and geophysical data sets are fundamental in attracting significant mineral exploration company investment and hence the development of new mineral resources. As Assistant Director, Geoscience Mapping (GSWA), Dr Tyler is strategically involved in the scientific design and implementation of WA's $130 million Exploration Incentive Scheme (EIS), focused on acquisition and rapid publication of high-quality, digital geoscience, deep seismic, geochemical and isotopic data sets relevant to exploration in underexplored areas. His impact is that this effort has resulted in more than 20 new mineral discoveries.

DR ALEX WONHAS FTSE

Executive Director – Environment, Energy and Resources, CSIRO (NSW)

Dr Wonhas' high-impact achievements include the development of a widely used reference carbon abatement cost curve for Australia, a 'blueprint' for legislation that enabled Queensland coal seam gas developments to proceed, and management of the formation of an array of successful spin-off companies. Dr Wonhas has been instrumental in shaping a number of nationally and internationally relevant projects, including development of the Australian National Outlook 2015 and establishment of the Future Grid Forum.

2016 FOREIGN FELLOW

PROFESSOR ROBIN GRIMES FRENG FTSE

Professor of Materials Physics, Imperial College London (UK)

Professor Robin Grimes FREng is an acclaimed authority in the area of materials for energy applications, especially nuclear. His pioneering work on nuclear fuel performance overturned scientific thinking about fission product behaviour and has had a major impact on the nuclear energy sector both in the UK and internationally. He led the UK delegation to the International Atomic Energy Agency 58th General Conference and currently serves as Chief Scientific Adviser to the UK Foreign and Commonwealth Office.

2016 HONORARY FELLOW

HE MAJOR GENERAL (RET'D) DAVID HURLEY AC DSC FTSE

Governor of NSW (NSW)

General Hurley had a distinguished military career over more than four decades, retiring in 2014 as Chief of Defence. He became the 38th Governor of New South Wales in October 2014 with a five-year commission. He has advocated for innovation and scientific research and STEM education and has supported public debate on the future of society at both state and national levels. He promotes NSW industry, especially innovation and scientific research, and STEM education through a 'futures' program with an annual Forum, which he hosts at Government House.

ATSE PEOPLE

Three Fellows on NEM review panel

Chloe Munro

Two Fellows will join Australia's Chief Scientist Dr Alan Finkel AO FAA FTSE on the National Electricity Market (NEM) review.

Dr Finkel will chair the review and will be joined by four others, including Clean Energy Regulator CEO Dr Chloe Munro FTSE and NSW Chief Scientist and Engineer Dr Mary O'Kane AC FTSE.

Others will be former Origin Energy CFO Ms Karen Moses and former Energex CEO Mr Terry Effeney.

The panel will review Australia's energy security, which has been under scrutiny since South Australia's state-wide black-outs in September.

It is scheduled to deliver its first report to a Council of Australian Governments meeting on 9 December. The review will draw together multiple reviews into the NEM and SA power crisis being conducted by energy agencies including the Australian Energy Market Operator and the Australian Energy Market Commission.

PETER JONES MADE HIS LIFE IN SUPERCOMPUTERS

Dr Peter Jones FTSE was a leader in computer development in its early days in Australia. He was recognised nationally and internationally for his skills and had a long personal and professional relationship with Seymour Cray, known as the 'father' of supercomputing.

He was founder and Chairman and Managing Director of Techway Ltd, established in 1979 to service the needs of large computer users in the public and private sectors in Australia.

A former member of the Prime Minister's Advisory Committee on Science and Technology (1984–90) and a Fellow since 1990, he died in Sydney recently aged 83.

A science and engineering graduate of the University of Sydney, with a PhD in Aeronautical engineering, Dr Jones was a computing specialist working on supercomputers from 1960 and playing leading roles in academic and commercial computer development.

He worked as a systems designer at Manchester University on the Atlas computer, one of the earliest supercomputers, before working on the installation of the first high-performance computers in Australia for CSIRO and the Bureau of Statistics.

As a systems engineer on the Control Data 6600 computer in the US in 1965 he began his long association with Seymour Cray, the American electrical engineer and supercomputer architect who designed a series of computers that were the fastest in the world for decades.

Peter Jones

For the next 10 years he alternated between senior academic roles in Australia (University of NSW and the Australian National University) and computer applications in the US – first as a designer with Control Data and later as founder and VP for R&D for Networks Systems, which pioneered high-speed data communication and local area networking.

Her founded Techway in Australia in 1979 and introduced Cray Research, Network Systems, Storage Technology, Oracle and other leading computer companies into Australia. Techway established circuit board and computer manufacturing facilities in Sydney and partnered Network Automation in developing high-performance packet switch networks.

He was a member of the Australian Telescope Steering Committee (1987–91) and chaired the Sydney University Science Foundation for Physics from 1993–96.

In 1996 he founded CTEC and Home Communications, private companies, to develop and commercialise advanced internet applications and worked as a consultant on high-performance computer and communications systems.

PETER DOWD WINS KRUMBEIN MEDAL

Professor Peter Dowd FREng FTSE was awarded the 2016 Krumbein Medal at the 35th International Geological Congress in Cape Town recently. He also delivered the Krumbein Lecture.

Peter Dowd

The award, established in 1976, is made in alternate years by the International Association for Mathematical Geosciences to a senior scientist for career achievement and distinction in the application of mathematics or informatics in the earth sciences.

This is the highest honour in Mathematical Geosciences and it is the first time since the inception of the award 40 years ago that it has been awarded to an Australian or to anyone working in Australia.

Professor Dowd, a Fellow since 2006, is Professor of Mining Engineering and South Australian Government Chair in Geostatistics and Quantitative Geology in the School of Civil, Environmental and Mining Engineering at the University of Adelaide.

KATHRYN FAGG TO HEAD CEW

ATSE's Industry and Innovation Forum Chair and Gender Equity Working Group member Ms Kathryn Fagg FTSE has been elected President of Chief Executive Women.

She is a member of the Board of the Reserve Bank and is a prominent company director as well as chair of the Melbourne Recital Centre and the Breast Cancer Network Australia.

Ms Fagg, who is a director of Boral, Incitec Pivot and Djerriwarrh Investments, has replaced Ms Diane Smith-Gander as president of CEW.

She began her professional career as a petroleum engineer with Esso Australia before joining McKinsey & Co. She then worked for ANZ, Bluescope Steel and Linfox before becoming a non-executive director.

The Australian Council of Superannuation Investors notes there are still 17 of the top 200 Australian companies with no women on their boards and 63 companies have only one female director.

ATSE PEOPLE

Langworthy wins NT taskforce job

Clunies Ross Award winner Mr Alan Langworthy has been appointed to head the Road Map to Renewables expert taskforce by the Northern Territory's newly elected government.

Alan Langworthy

His work on energy-efficient power systems is internationally renowned and earned him a 2009 Clunies Ross Award.

When he established Powercorp in Darwin nearly 30 years ago, his aim was to automate the wide variety of diesel generator power stations in the Northern Territory for the Power and Water Authority.

Since then Powercorp has become a world leader in renewable energy and has delivered high-penetration wind–diesel systems that now power remote communities from Antarctica to the Azores.

MANAGING FOR A PREFERRED FUTURE

Noted botanist and University of Western Australia Professor Stephen Hopper AC FTSE, former head of the world-renowned Kew Gardens in London, was a keynote speaker at the South West Science Council conference at Bunbury, WA, in October.

He provided a framework through which attendees could understand the naturally occurring challenges inherited from past change on geological and evolutionary scales.

The conference was titled 'The ocean, waterways and landscapes: science, technology, engineering and mathematics (STEM) in action'.

ATSE is a supporter of the Council, chaired by former WA Division Chair Professor Adrian Egan FTSE

"Under the 'Inspiring Australia' banner, the Council is hosting a range of highly respected speakers who will open our minds to change through the magnifying glass of research into 'what was, what is and what may yet be' as we manage our way into a preferred future," Professor Egan said.

Stephen Hopper

"Science and technology underlie all we can do to protect the environment and our natural resources, while we also stimulate agricultural productivity, innovate in business, create employment and protect our amenities.

"Economic, social and environmental pressures demand strong response, with science a primary tool in that endeavour."

KAREN REYNOLDS NAMED WINNOVATION WINNER

ATSE director Professor Karen Reynolds FTSE, from Flinders University, won the Engineering category of the 2016 SA Winnovation Awards, positioned to elevate South Australia's innovative women.

Professor Reynolds developed the Medical Device Partnering Program, an innovative model for collaboration between researchers, end users and commercial partners, which is now helping catalyse the medical technology industry in SA.

Karen Reynolds

Her program is now helping small-to-medium enterprises (SMEs) reclaim a share of Australia's post-manufacturing economy, has engaged with more than 300 companies or inventors, and helped pioneer a new model for collaboration between researchers, end users and commercial partners.

ATSE Vice President Professor Tanya Monro FAA FTSE, Deputy Vice-Chancellor R&D at the University of SA, was a finalist in the Technology category.

Professor Monro was nominated for her vision to create new tools for measurement to help a diverse range of industries such as agriculture, health and mining, to ask questions and find answers previously impossible. The innovation was to use optical fibres to develop new types of probes and gain access to *in situ*, real-time measurement.

MURRAY SCOTT NAMED AN ICAS FELLOW

Chairman of specialist engineering firm Advanced Composite Structures Australia Pty Ltd, Professor Murray Scott FTSE has been elected as an Honorary Fellow of the International Council of the Aeronautical Sciences (ICAS).

He was honoured at the 30th annual ICAS Congress in Korea recently for his exceptional personal contributions and service to the objectives of ICAS over 22 years since he attended the 19th Congress in California.

He has participated in all 12 Congresses since then and has been part of the Australian teams that took ICAS to the Southern Hemisphere for the first and second times – Melbourne in 1998 for the 21st Congress, and Brisbane in 2012 for the 28th Congress.

He served two years as President (2013-14), which included the historic 29th Congress in St Petersburg, Russia. Before this he also served for the two years as Program Committee chair.

His Fellowship makes him the most recent addition to a list of 24 past and 17 current prominent aeronautical engineers and scientists that originated with Theodore von Kármán, the founder of ICAS, in 1957.

Murray Scott

ATSE PEOPLE

Bronwyn Harch joins ISA Board

Bronwyn Harch

Professor Bronwyn Harch FTSE, Executive Director of the Institute for Future Environments and Professor of Applied Statistics at the Queensland University of Technology, has been appointed to the Board of Innovation and Science Australia (ISA).

Professor Harch is an environmental statistician who brings digital technology and mathematical sciences to sectors like agriculture, environment, health, manufacturing and energy.

She is a Member of the Statistical Society of Australia and the International Statistical Institute and has served as a Board Member of the International Environmetrics Society and its President (2013–15).

She left CSIRO for QUT in 2014 having held senior positions in CSIRO Flagships (Deputy Director, Sustainable Agriculture) and Divisions (Chief of CSIRO Mathematics, Informatics and Statistics – then CSIRO Computational Informatics).

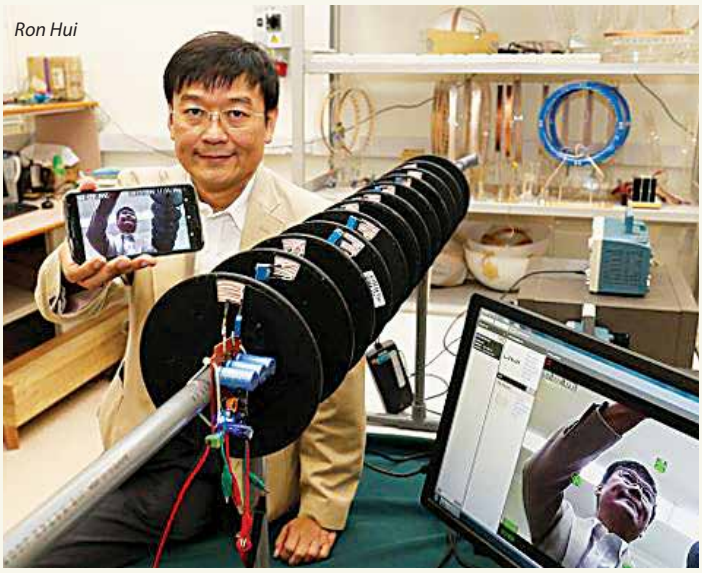
Her CSIRO roles involved research initiatives with government and industry, predominantly in the environmental and agricultural sectors. These large-scale projects combined statistical expertise with the expertise of scientists from other parts of CSIRO as well as universities, government and industry.

Chief Scientist Dr Alan Finkel AO FAA FTSE is Deputy Chair of the ISA Board.

RON HUI ELECTED TO RAENG

Professor Ron Hui FREng FTSE, Professor of Power Electronics and Professor of Electrical Engineering at the University of Hong Kong, has been named a Fellow by the Royal Academy of Engineering in the UK.

Professor Hui, a Fellow since 2010, was recognised for his research spanning decades and focusing on power electronics, with emphasis on energy-saving features, environmentally friendly technologies and reduction of electronic waste.



Ron Hui

Professor Hui and his team are studying new omnidirectional wireless power transfer for 3D wireless charging and electric springs for stabilising power systems with increasing renewable energy generation.

Besides publishing extensively in top-tier research journals in power electronics, he has more than 55 patents adopted by industry. His achievements in planar wireless power transfer and sustainable lighting technology have been previously recognised by the US Institute of Electrical and Electronic Engineers and the Institution of Engineering and Technology UK.

HULL HONOURS ERIC WOLANSKI

James Cook University scientist Professor Eric Wolanski FTSE will receive an Honorary Doctorate of Science from the University of Hull in the UK in January.

Professor Wolanski will be honoured for his outstanding achievements in estuarine ecohydrology, which focuses on the interaction between physical and biological processes determining ecosystem health in estuaries, coastal wetlands and coral reefs.

Hull University is the pre-eminent UK estuarine research institute.

Professor Wolanski said the Institute of Estuarine and Coastal Studies at Hull University required computer models that predicted the ecosystem health of estuaries.

"This is precisely where I come in with my model based on my 35 years' experience as an oceanographer at AIMS (Australian Institute of Marine Science) and JCU.

"This model can do that because it combines physics, chemistry and ecology. This model is increasingly used worldwide – at present in Portugal, Palau, Tanzania, India and China," he said.

Professor Wolanski has previously been awarded an Australian Centenary medal, and a Lifetime Achievement Award by the Estuarine Coastal Sciences Association. He is a member of the ARC College of Experts, the Australia-China Science and Research Fund (ACSRF), and the Scientific and Policy Committee of the Japanese government agency Environmental Management of Enclosed Seas (EMECS).

Eric Wolanski

Best minds come together with UQ and Boeing partnership

In an Asia-Pacific first, UQ is collaborating with Boeing in a key partnership that will include a new research facility at the UQ St Lucia campus. A number of Boeing staff will work at the St Lucia campus, collaborating with UQ researchers and students on topics including autonomous systems and environmental monitoring technologies.

This partnership builds on UQ's long history with Boeing that has included a range of support for students and investment in diverse research projects. Boeing will be housed in UQ's Faculty of Engineering, Architecture and Information Technology precinct. The facilities are expected to open in the first quarter of 2017. To learn more visit **eait.uq.edu.au**.

The Federal Government's 2015 Excellence in Research for Australia exercise confirmed The University of Queensland as one of the nation's top three universities, measured by the quality of its comprehensive range of specialised research fields. UQ's outstanding critical mass offers researchers significant interdisciplinary capability.

Join more than 4,000 students currently pursuing a research higher degree at UQ. Visit **uq.edu.au/grad-school**.

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