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ATSE

FOCUS

ENGINEERING OUR FUTURE

ENGINEERS ARE A CRUCIAL PART OF THE COLLABORATION THAT IS OUR FUTURE

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 **2017 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 in the evolving health sector

The **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.

Registrations now open
14 June 2017, Brisbane
www.atse.org.au/ageing

Speakers presenting at the **Dialogue** will include:

- **Professor Ian Frazer AC FRS FAA FTSE FAHMS**, Ambassador and Chair, Translational Research Institute, Professor, Faculty of Medicine, University of Queensland, President, Australian Academy of Health and Medical Sciences
- **Professor Ingrid Winship**, Executive Director of Research, Melbourne Health, Chair of Adult Clinical Genetics, University of Melbourne
- **Professor Hugh Bradlow FTSE**, ATSE President and Chief Scientist at Telstra Corporation
- **Dr Denise Furness**, Molecular Geneticist and Nutritionist, Director/Consultant, Your Genes & Nutrition
- **Dr Elizabeth McGrath**, Director, Conformity Assessment, Medical Devices Branch, Therapeutic Goods Australia

For more information on the **Dialogue** program and issues paper see **www.atse.org.au/ageing**

For information on sponsorship packages contact **sue.wickham@atse.org.au**

AUSTRALIAN ACADEMY OF TECHNOLOGY AND ENGINEERING

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Front cover photo: Engineering is collaboration (Photo: iStock).

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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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API

The Australian Power Institute

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 ASHLEY BRINSON AND RICHARD KELL
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The future is engineering.

Engineers are key to our future

PHOTO: ISTOCK

ENGINEERING OUR FUTURE Boundaries are simply dissolving – national boundaries, economic boundaries and technology boundaries – and are changing traditional engineering roles.

Innovation – hence change – has always been integral to engineering. Engineers have built the infrastructure that defines present contemporary life: modern cities, transportation, energy systems and brilliant digital communications. New generations of technology promise even higher technical performance.

It is clear that the profession is changing: interactively, with the societies that engineers serve, and reactively, with the technology the profession itself is creating.

The catalogue of engineering disciplines is expanding with data analytics, robotics and artificial intelligence as Australian engineers shape our highly globalised profession. A future is unfolding rich with multidisciplinary challenges.

A National Innovation and Science Agenda video features children declaring that the most exciting jobs of the future do not even exist yet. A girl proclaims, "When I grow up I'm thinking I'll be … a tele-remote surgeon," and a boy announces he will be a "3D printing architect". The future will be limited only by our imagination.

The future of the engineering profession will be defined not only by the remarkable technical opportunities faced in today's hyper-connected, global society, but also by community aspirations.

To explore this, we consider today's global context, from outside the profession, according to the dimensions of boundaries, aspirations, security and social expectations.

BOUNDARIES HAVE DISSOLVED

Historic boundaries that separated nations are less meaningful today.

The 2010 Arab Spring uprising sparked a chain reaction that rapidly spread on Facebook and YouTube. From Tunisia to Libya, Egypt and Syria, expectations moved swiftly from the incident's epicentre, culminating in a vast migration of Syrian refugees across Turkey into Europe.

Today's crises are not contained and isolated. Problems that start locally spill rapidly over porous borders.

Similarly, environmental challenges are not confined to national borders. Ozone-depleting chlorofluorocarbons (CFCs) required multilateral international action. Although CFC manufacturers denied any problem existed, the concerns were real and only international action could address the scale of the damage. Unilateral action by any one country would not suffice.

Sulphur dioxide emissions also demanded international response as pollution emitted from Austria very rudely crossed the German border and attacked Cologne Cathedral. Only multilateral cooperation could address acid rain.

Today's environmental challenge is the climate impact from greenhouse gas emissions. The solutions matrix is highly complicated, because large emitters are the energy and transport systems on which we are totally reliant.

No single engineering solution addresses reliability, affordability and emissions. Engineers Australia calls for professionals to rise to the challenge and to "exercise leadership and to practise engineering to foster the health, safety and wellbeing of the community and the environment".

Economic boundaries have also dissolved. Free trade agreements (FTAs) have redefined Australia's relationships to regional economies. Described as 'the Rise of the Rest', rapid Asian modernisation is both a threat and an opportunity for engineers.

By 2030, an additional 400 million people in rural China and India will join the global middle class, as sophisticated and newly built Asian cities rise in the north. Modernisation and middle-class wealth drive demand for Australian commodities and value-added specialties such as vaccines and biomedical devices.

Technology boundaries are dissolving, blurring and merging. Global innovation cycles occur rapidly. Computers and digitisation are ubiquitous. Data movement across boundaries amplifies and exaggerates the impacts of FTAs and the Asian Rise.

Google, Facebook, Amazon, Uber and Alibaba exemplify the dominance of big data, mobile computing and the digital platform economy. Modern projects are executed globally.

As an example, in Geoje, Korea, the Australian subsidiary of Royal Dutch Shell is presently commissioning the floating LNG vessel *Prelude*, the largest ever man-made sea vessel. Technip France, Samsung Engineering and Korean Gas are delivering the $16 billion engineering marvel.

Execution of the complex project was enabled through highly synchronised, highly distributed digitised engineering networks. Virtual teams coordinate commissioning between Perth and Geoje exploiting the boundary-less world to deliver a project that might have been technically impossible or economically unfeasible in yesterday's disconnected economy.

Data science is merging across boundaries as engineers apply mathematics in remarkable ways.

Boundaries are simply dissolving – national boundaries, economic boundaries and technology boundaries – and are changing traditional engineering roles.

ASPIRATIONAL RESPONSE

The second global force influencing the profession flows from this boundary-less world.

Today's engineers aspire to deliver a better quality of life. Communities and the profession share the dream of building a better world. Humanitarian engineering has evolved to a sub-discipline of modern civil engineering. Engineers Without Borders and RedR apply engineering talent to aid developing countries in times of need.

Further evidence of aspiration is the profession's determination to raise participation of women in engineering. Australia's engineering has only 11 per cent female senior managers.

Stronger representation is needed not just for reasons of social fairness. The nation must add more women to the engineering capacity because Australia cannot afford to run a national economy without half the potential skill on-deck.

McKinsey reports the compelling economic case that gender and ethnic diversity are consistently correlated to higher financial performance and productivity.

SECURITY, FEAR AND DISRUPTION

Today's global context would be incomplete without acknowledging security concerns. Despite living in a world without boundaries, despite strong aspirations, fear looms.

A reaction is occurring against globalisation. The Brexit vote, the Trump phenomenon and the domestic resurgence of nationalist Australian politics expose emotions generated by the disruptive impacts of globalisation and international security incidents.

The world without boundaries is under question as people demand answers to legitimate fears.

There is global competition for scarce resources. The mining boom showed how hungry growing economies in Asia consume resources to build new cities that house and raise new middle classes. Australian iron and copper built the boom of China.

Population growth necessitates engineering solutions to increase global supplies of food and water.

Australia's recent LNG export projects fuel China, Korea and Japan but, domestically, gas prices have risen sharply because Australia is connected to Asian economies – an economic side-effect that seems that have surprised some decision-makers.

Simultaneously, competition and militarisation in the South China Sea raise fears as China, Taiwan, the Philippines and Vietnam assert claims over subsea resources. Australia has responded by committing massive defence investments, and engineering is the key to this initiative. Cyber risks undermine community feelings of security as we are progressively more reliant on digital systems.

As engineers increasingly automate the economy, the security of traditional employment is threatened. Opportunities are created, but many employment activities will disappear as robots and artificial intelligence systems displace human work.

As innovations cross boundaries, some spectators mistake globalisation as the cause for disruption, but the reality is far more complex. Future disruption will disproportionately affect regional rural economies, and economic gains may be concentrated in urban centres.

Middle class knowledge professions will be transferred to AI systems in a process described by some as the 'hollowing out of the middle'. Engineers are at the centre of this social dislocation and will need to contribute to potential solutions.

NEW SOCIAL EXPECTATIONS

The fourth global context dimension is the effect of digital media, its influence on social expectations and new constraints on technology.

Engineers are building robots, delivering artificial intelligence and launching autonomous cars. Facebook and Twitter are the offspring of modern IT, and hyper-connected, globalised *social speed* interacts strongly with our work and the identity of our profession.

The future we are building interacts to amplify the community's voice. Cloud-based social media is a platform for alternative facts that fuel and intensify confusion during rapid change, raising an imperative for engineers and scientists to make the real facts understood.

The Engineering Deans of Australia's leading universities recently identified 10 technology clusters predicted to shape the future: energy; future cities; advanced materials and manufacturing; big data; robotics; precision farming and food security; medtech and health; cyber security and networked society.

In all fields, continuing education and ever closer collaboration between industry, academia and government are essential to effective engineering delivery in the future.

Perhaps equally important to the technical themes and challenges, we must recognise that engineers work within a complex social system. Communities shape our profession in new ways driven by new senses of boundaries, legitimate and imagined security concerns, and new social concerns.

The rapid technology changes that engineers create *interact* with our profession, driving our community's voice and expectations.

We live in an age of escalating community expectations, requiring the engineering profession to equip itself to rise and meet new challenges, to innovate and commercialise solutions that deliver a prosperous future. ⊙

Mr Ashley Brinson is Executive Director of the Warren Centre for Advanced Engineering at the University of Sydney. He has broad experience across the technology and innovation spectrum and more than 25 years in industry. An inventor on five PCT patent sets, he has extensive experience in the silicon industry, having designed, built and managed large facilities in the US, the UK and China. He holds a BChE from Georgia Tech, an MBA from Rutgers and a Juris Doctor from Sydney University Law School. Mr Brinson is a lawyer of the Supreme Court of NSW, a Fellow of Engineers Australia and a Fellow of IChemE.

Mr Richard Kell AM FTSE is a Chartered Civil Engineer who has spent his working life as a consulting engineer in infrastructure engineering. Formerly Chair of the major Australian-based International consultant Cardno, he is now a consultant to the firm and continues his involvement on bridge, highway, marine, water and building projects, in Australia and overseas including in PNG and the Pacific, Malaysia, Abu Dhabi, Indonesia and Vietnam. He is Chairman of the Warren Centre for Advanced Engineering, was World President of FIDIC (2003–05), is an Honorary Fellow of Engineers Australia and has received EA's John Connell Medal (2000) and Peter Nicol Russell Medal (2016).

ATSE

2017 ATSE NATIONAL TECHNOLOGY CHALLENGES DIALOGUE

AUSTRALIAN OF THE YEAR KEYNOTE AT ATSE INNOVATION DINNER

ATSE cordially invites you, your staff, guests and partners to attend the ATSE Innovation Dinner where the Clunies Ross Awards will be presented at Brisbane City Hall on 14 June 2017.

This year's Keynote speaker is 2017 Australian of the Year, Professor Alan Mackay-Sim, stem cell and neuroscientist.

The Clunies Ross Awards are presented in three separate categories; *Entrepreneur of the Year, Knowledge and Commercialisation,* and *Innovation*. Now in its 27th year of being presented, the Clunies Ross Awards will again recognise the outstanding applications of science and technology that provide economic, social and/or environmental benefit to Australia.

The ATSE Innovation Dinner is held in conjunction with the ATSE National Technology Challenges Dialogue. This year the topic is *The Crisis in Ageing: Technology to manage the challenges in healthcare*. The MC for the Dialogue and Dinner will be Dr Norman Swan, Producer/Presenter, ABC Radio National *Health Report*.

Registrations are now open. To register visit www.atse.org.au/ageing
Sponsorship packages are available, email sue.wickham@atse.org.au

CluniesRossAwards

DETAILS

Wednesday 14 June 2017
Brisbane City Hall
64 Adelaide Street, Brisbane 4000

$160 per person or $1,440 for a table of 10

6.00pm Pre-dinner drinks
7.00pm Official proceedings
Black tie optional

PRINCIPAL SPONSOR

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AUSTRALIAN ACADEMY OF TECHNOLOGY AND ENGINEERING

BY ANTHONY BARRY
anthony.barry@aurecongroup.com

Imagining our built future.

IMAGE: AURECON *JUST IMAGINE* BLOG

Our built environment is changing – fast

ENGINEERING OUR FUTURE Creativity and 'smart' together are opening up new opportunities and delivering a new future for people, communities and cities.

Engineering is changing life and life is changing engineering. Our world is one of rapid change socially, technologically and commercially. Change facilitated by technology, in some cases led by it, is infiltrating every aspect of life as science fiction becomes science fact.

Our built environment, in particular, is changing fast. This is an outcome of social and economic demands, changes in skill and resource supply, business models, workplace practices, technological development and disruption, as well as a creative exploration of the possible and the strength of human aspiration.

We know we are in for an exciting ride. What might the journey entail?

We are in a new era of creativity that will deliver a new future for our infrastructure and our buildings.

Infrastructure intended to have a long life has ceased to perform its useful function or to meet new requirements, well short of intention. Other infrastructure is having its life extended, demand managed, capacity augmented or being re-purposed.

We are experiencing growth in digital technology to capture base data, big data, to support planning and design, to moderate demand, to flex capacity and to dynamically learn and improve operations.

Engineering technology is enabling designers to return to modelling, to experiment with form, to test new materials, to precision manufacture building components remote from site, to use recycled materials and to monitor and manage the performance of structures and systems.

Whether it be data-capture drones, intelligent systems, 3D printing and manufacture or robotics, technology is enabling better planning, envisaging, collaboration, prototyping, precision, quality and resilience in a way we have never experienced. It is enabling new methods of communication, approvals, project management, sourcing and project delivery.

Technology is offering new approaches to our projects at a price point which is

ATSE

BATTERHAM MEDAL

FOR ENGINEERING EXCELLENCE

One of Australia's most innovative young engineers will win the 2017 Batterham Medal.

NOMINATIONS OPEN 1 JUNE AND CLOSE 31 AUGUST.

The Batterham Medal is an early career award for a graduate engineer who has achieved substantial peer/industry recognition for his/her work in the past five years. The Academy administers the award on behalf of the Group of Eight Deans of Engineering and Associates and the Medal will be awarded at ATSE's Oration Dinner on 24 November 2017 in Sydney.

The winner will receive the Batterham Medal and a cash prize of $5000.

THE WINNER WILL BE AN ENGINEERING GRADUATE OF AN AUSTRALIAN UNIVERSITY, UNDER 40 AT 1 JANUARY 2017 AND WILL:

1. have demonstrated excellence, innovation and impact in a field of engineering;
2. be clearly acknowledged by peers for a signature contribution to engineering in the five years prior to his/her nomination; and
3. have advanced the standing of the engineering profession.

The Batterham Medal recognises **Professor Robin Batterham AO FREng FAA FTSE**, an Australian science and technology leader who was Chief Scientist of Australia from 1999 to 2006, President of the Academy from 2007 to 2012 and is Kernot Professor of Engineering at the University of Melbourne.

THE BATTERHAM MEDAL GUIDELINES AND NOMINATION FORM ARE AVAILABLE AT www.atse.org.au/batterham-medal

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NOMINATE AN INNOVATIVE YOUNG ENGINEER TODAY.

GROUP OF EIGHT AUSTRALIA

AUSTRALIAN ACADEMY OF TECHNOLOGY AND ENGINEERING

affordable and effective, accessible at a point in the development process which reduces risk to the enterprise and the participants. It enables the participants in the enterprise to focus on the success of the enterprise while effectively manage their organisational risks.

Solutions are being found which are 'bespoke' and, at the same time, efficient.

Buildings, infrastructure and cities are becoming 'smart' because we can now integrate functionality, processes, demand data, performance history and deliver that functionality in a way which is personal, dynamic and responsive to changing needs. Intelligence and insight are captured, retained and employed to deliver a better service.

Creativity and 'smart' together are opening up new opportunities and delivering a new future for people, communities and cities.

We are beginning to understand the linkages between good design and human performance and wellbeing. We are appreciating the impacts of space, outlook, temperature, light, colour and air quality.

This understanding and increasing belief by governments, owners, developers and consultants is stretching our aspirations for the built environment. We have moved well beyond utility and function to create places and spaces in which we live, work and move that enhance our aspiration for life and contribute to our individual and societal wellbeing.

RESILIENCE NEEDED

Our environment is also changing, as is the societal expectation of the built environment and our ability to manage impacts. Exploring these issues is complex and, without wishing to oversimplify them, those working in the built environment are seeking to make infrastructure and buildings more resilient. Resilience is required to improve reliability, safety, survivability, sustainability and service performance of the built environment.

The market for many built forms is changing very fast and it is difficult, for what may have been historically interesting buildings, to meet the needs of modern living and work. Households and businesses equipped with the latest technology and a very liveable environment are preferred both for competitive advantage and for wellbeing. It is difficult for many older built forms to meet the market in these respects.

This challenge is critical in infrastructure as well. Can the underground railways built in the late 19th and early 20th centuries in cities such as London, New York and Sydney be renovated to meet the 21st century needs of major cities and provide the facility and efficiency of systems like we find in young cities such as Singapore?

In younger cities across the world, we have seen massive shifts in economic power, rapid urbanisation and sustainability made core to the built environment, fundamentally changing our approach to transport, power generation and communication. How do we help cities to transition to this new world, keep them competitive and make them exciting and liveable for all?

There is a shift towards rapid obsolescence and a strong trend to replace rather than renovate. This has been accelerated as our world embraces disruption as a fundamental driver of change. Can we mobilise disruptive technologies, such as autonomous vehicles, to achieve greater capacity and, in a sense, repurpose existing infrastructure to reinvent our cities?

It may also be simplistic, but it is very clear we are doing new things with new materials in different ways.

New materials have always been and will continue to be developed for use in infrastructure and buildings. While stone, timber, concrete and steel have been the stock in trade of engineers for centuries, they have always been innovated and improved. We are now seeing new materials, with sustainable sourcing, lighter weight and better performance, coming into their own in the built environment.

These changes will continue to improve efficiency and effectiveness and enable new creative forms to be designed, manufactured and installed.

Construction is also changing. Off-site manufacture provides many significant benefits, increased precision, improved site safety, increased speed, improved finishes and improved environmental performance to name a few.

PRINTING TECHNOLOGY

Printing technology has developed to become an experimental construction technique – using a robotic arm to print the basic structure of a bridge or house, for instance. These technologies are enabling construction of innovative forms on constrained sites, minimising impacts on neighbouring communities.

Mobile device and sensing technology is impacting the built environment. It is fundamentally changing the way we work and communicate with each other. It is also enabling us to remotely monitor and control almost every system element of houses. We can now remotely monitor home security and control the home environment, initiate robots to clean our floors, turn on our sound systems and watch our pets from work, for example.

Building systems, not so long ago pre-programmed and scenario controlled, will soon be integrated, intelligent and responsively delivering a level of comfort and service occupants have come to take for granted. They will be connected with the Building Information Modelling used in design and construction for sophisticated operations and visual asset management.

We are entering one of the most exciting periods for the built environment, one in which creativity flourishes and technology thrives, where – if you can imagine and conceive a new idea – a designer can give it life and model the built form and the user can envision it using virtual and augmented reality.

Multidisciplinary teams, approval authorities, contractors and suppliers then work on collaborative platforms to deliver the project most efficiently.

The project is manufactured off-site and assembled on-site using a palette of materials, forms and finishes which are brought together with advanced systems to create the desired form and living and working environment.

Plainly put, it's an exciting hour to be an engineer! ⊙

Mr Anthony (Tony) Barry FTSE has more than 35 years' experience in engineering with a particular focus on infrastructure. He has held executive positions in leading consulting firms. He has been responsible for parts of the business in Africa, Asia, Australasia and the Middle East. Mr Barry was a member of Aurecon's Global Board and its predecessor Connell Wagner for more than 15 years and is a non-executive director of a number of subsidiaries in the Aurecon Group. He was National President of the Association of Consulting Engineers Australia (2004–06) and is a Board member of the International Federation of Consulting Engineers.

▶ SEE PAGE 17: *ARE 3D PRINTED HOUSES NEXT?*

BY ADRIAN PIANI
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Environmental engineering – getting it together.

Environmental engineering: our great new export

ENGINEERING OUR FUTURE With their abundance of knowledge and experience and a healthy global perspective, Australian environmental engineers have much to offer the global engineering industry.

Environmental engineering is a relatively new speciality within the engineering profession. Born out of the environmental movement of the 1970s, environmental engineering was formally recognised as a separate engineering discipline in 2000 with the creation of the Environmental Engineering College of Engineers Australia.

Since then, the profession has grown in stature and popularity. Environmental engineers are now indispensable to most infrastructure projects.

Australian environmental engineers bring a unique blend of knowledge, skills and perspective and are a significant potential export for Australia.

To assess the value of an Australian environmental engineer as an export, it is important to consider what environmental engineers do, why their skills are so valued and the traits specific to Australia environmental engineers.

THE CREATION

Engineers through the ages have played a major role in the development of our cities, towns and rural landscapes. Engineering creations, such as the steam engine, computers and sanitation systems, have created the foundation for the standard of living we now enjoy.

However, historical engineering design processes were undertaken without significant regard for their impacts on our environmental and natural systems.

During the 1970s, the green movement picked up momentum and people started to take note of changes in the environment linked to major infrastructure: polluted waterways, degraded land and destruction of sensitive areas. There was increasing realisation that development had come at a cost, and much of that cost was borne by the environment.

Governments responded to environmental concern with legislation and regulations stipulating that environmental impacts were to be identified and managed. Globally, acts and treaties were developed such as the Ramsar Convention on Wetlands, Convention on Biological Diversity and now the UN Sustainable Development Goals.

The engineering industry was also active in this environmental conversation, realising engineering solutions needed to be more sustainable and impacts on the environment needed to be minimised. Environmental studies were added to university curricula and a new degree was offered – Environmental Engineering.

Environmental engineering was firmly established as a core part of the Australian

engineering profession in 2000, when Engineers Australia established its College of Environmental Engineering.

THE RESULT

At its genesis, environmental engineering was based on aspects of civil engineering, chemical engineering and environmental science. Today, Engineers Australia describes environmental engineers as being concerned with protecting the environment through assessing how a project will impact air, water, soil and noise levels.

The scope of activity undertaken by environmental engineers is extremely broad – technically, spatially and temporally. In any one project, environmental engineers could be involved at the design phase, predicting impacts and assessing solutions, at the construction phase, overseeing and mitigating impacts, and at the operation phase monitoring and assessing activity.

Environmental engineering projects include remediation of contaminated sites for change of land use, planning and design for waste treatment and disposal, research and development of alternative energy sources, management plans for the conservation of natural resources and response plans for natural disasters.

As part of the Define Your Discipline (DYD) project during 2010–12, environmental engineering professionals participated in workshops designed to define graduate outcomes for environmental engineering. A key aspect of this work was to define four underpinning principles of the environmental engineering discipline (Dowling, D. and Hadgraft, R. 2014):

1 Sustainability

Environmental engineers produce outcomes based on the principles of sustainable development including, but not limited to: applying the precautionary principle; undertaking full life-cycle analyses; minimising impacts; using resources economically and efficiently, particularly non-renewable resources; appreciating the effect of climate change; ensuring socially equitable outcomes; and evaluating engineering outcomes using triple bottom line techniques.

2 Systems thinking

Environmental engineers use holistic systems thinking and approaches to understand, investigate, model and design natural, constructed and engineering systems, and the interactions between those systems, while accounting for the interconnected social and economic systems that lie within the scope of a project. This understanding enables them to explicitly acknowledge inherent uncertainties and risks and ensure that the benefits of a project on natural and constructed environments are maximised and negative impacts are minimised.

3 Integrated approach

Environmental engineers often play a leading role in integrating the work of the members of multidisciplinary teams. They have a big picture perspective that enables them to analyse, evaluate and synthesise inputs from a range of disciplines to achieve integrated outcomes.

4 Critical thinking

Environmental engineers use critical thinking skills to resolve complex and multidisciplinary problems.

The DYD project also identified that environmental engineers work across seven generic areas:

- water resources and supply;
- stormwater management and reuse;
- water and wastewater treatment;
- soils and geology;
- resource and waste management;
- air and noise; and
- energy systems and management.

Plainly, the environmental engineering profession is wide-ranging and there is scope for an environmental engineer to play a role in many different areas. Environmental engineers could be described as 'sustainability integrators'. They have a broad knowledge of environmental systems and engineering impacts, and bring their understanding to engineering projects to make them more sustainable.

They do this because they know intrinsically that sustainability is a good outcome and that minimising environmental impacts is good for all of us.

This systems-style thinking is valuable and it really sets the environmental engineer apart. Many professions can do one thing really well; that is their edge. The environmental engineer takes all the great things, and makes them better.

THE EXPORT POTENTIAL

Australian environmental engineers have a lot of value to add to the global engineering profession. The knowledge and skills they provide are a quintessential part of the services economy.

Of Australia's GDP, around 70 per cent is represented by the services sector and four out of five Australians are employed within this sector.

The Australian Government has recognised that environmental services are a great potential export for Australia.

The Department of Foreign Affair and Trade describes Australia as:

"… a world-class provider of a range of services, such as professional services, education and tourism, financial services, energy and mining-related services, environmental services and financial technology.

These are Australia's priority sectors for improving market access in global services trade reform efforts. Services also play an increasingly important role in our international trade, with services exports growing by an average of 3.2 per cent per annum over the last five years.

In 2015, total trade in services accounted for 21.3 per cent of Australia's total trade in goods and services, and services exports accounted for 20.9 per cent of Australia's total exports."

The knowledge-based expertise environmental engineers provide is easy to export around the world. As our global environmental conscious increases and our resources reduce, environmental engineers are playing an increasingly necessary role in providing smart solutions and adding value to engineering design.

Research carried out for the Queensland Chief Scientist in 2012 by Professor Graham Schaffer FTSE identified a number of areas where Queensland (and Australia in general) had a genuine competitive advantage that should be exported to global markets, including mining and minerals, unconventional gas extraction and infrastructure design in tropical areas.

The research also found that these engineering fields needed to be supported by a number of core competencies, including an understanding of sustainability and

sustainable development: "*As our resources become progressively more constrained, sustainable thinking will become increasingly critical to the entire engineering enterprise. It is therefore imperative that if we are to develop as a global leader in engineering services, then sustainability is a core part of the way that the business of engineering is taught, learnt, undertaken and managed.*"

Environmental engineering is therefore not just a valuable export in its own right, but can help underpin the broader export of Australian engineering excellence to the world.

Australia's environmental engineers, particularly, have a broad suite of skills to offer.

Australia, with its advanced economy and highly developed natural resources, has learnt a lot from its mistakes. The profession is fully aware of the environmental harm and negative impacts on ecological systems which can stem from the development of resources. Now, Australian practitioners are managing the impacts of these legacy activities, developing a wealth of knowledge in causes and effects, as well as designing, implementing and assessing new solutions.

This knowledge and expertise could prove invaluable to developing countries as they seek to find sustainable ways of driving economic growth and reducing poverty. This is highlighted by the international success of Australian initiatives such as the Leading Practice Sustainable Development Program (LPSDP) for the Mining Industry (Department of Industry, Innovation and Science, 2016) .

Australia's geography also provides environmental engineers with the opportunity to gain experience across many environments. Working in this country could involve working in areas such as desert, wetland, alpine, rainforest and marine regions. With this great diversity in terrain and climatic conditions come different issues and catastrophic events including floods, droughts, fires and storms. This breadth of experience enables Australian environmental engineers to develop a holistic and global sense of environment.

Australians are fundamentally interested in a healthy environment and enjoy a strong sense of place. Indigenous Australians experience a strong connectedness to the land and, over thousands of years of custodianship, they have developed specific and effective land management techniques.

Environmental planning increasingly involves consultation and collaboration with Indigenous Australians and, through the process, environmental engineers can gain great knowledge and perspective.

As an active nation, Australians also enjoy spending time outdoors and understand that access to natural environments can have great benefits to health and wellbeing. Unlike many other developed and highly populated nations, there is still access to many 'wild' places.

This all gives our environmental engineers a great contextual understanding of the value of our natural systems, and sensitivity to environmental and social outcomes.

Australian environmental engineers have much to offer the global engineering industry. With their abundance of knowledge and experience and a healthy global perspective, they would be valuable to projects all over the world. ⊙

Mr Adrian Piani is a Fellow of Engineers Australia and has been working in infrastructure and policy areas for more than 20 years. He has a Bachelor of Engineering (Natural Resources) from the University of New England and has spent the majority of his career working with government agencies at all levels supporting the development of policy in the water, environment, sustainability and infrastructure areas. He leads the Canberra office of the global infrastructure firm AECOM. He is active in professional associations and is Chair of the Environmental Engineering College of Engineers Australia. He is also President of the ACT Division of Australian Water Association and Chair of the ACT Consult Australia committee.

NEW DATA SCIENCE EUREKA PRIZE

Entries close 5 May for the 2017 Australian Museum Eureka Prizes. There are 15 prizes on offer this year including one new prize for data science excellence. In 2016, a team led by the University of Tasmania's Professor Ross Large FTSE won the UNSW Eureka Prize for Excellence in Interdisciplinary Scientific Research. Professor Gordon Wallace FAA FTSE, head of the ARC Centre of Excellence for Electromaterials Science (ACES) at the University of Wollongong, won the 2016 CSIRO Eureka Prize for Leadership in Innovation and Science.

THE 2017 EUREKA PRIZES

Research & Innovation

- NSW Office of Environment and Heritage Eureka Prize for Environmental Research
- University of Technology Sydney Eureka Prize for Excellence in Data Science
- UNSW Eureka Prize for Excellence in Interdisciplinary Scientific Research
- Australian Infectious Diseases Research Centre Eureka Prize for Infectious Diseases Research
- Johnson & Johnson Eureka Prize for Innovation in Medical Research
- ANSTO Eureka Prize for Innovative Use of Technology
- Defence Science and Technology Eureka Prize for Outstanding Science in Safeguarding Australia
- Macquarie University Eureka Prize for Outstanding Early Career Researcher
- UNSW Eureka Prize for Scientific Research

Leadership

- 3M Eureka Prize for Emerging Leader in Science
- CSIRO Eureka Prize for Leadership in Innovation and Science
- University of Technology Sydney Eureka Prize for Outstanding Mentor of Young Researchers

Science Engagement

- Department of Industry, Innovation and Science Eureka Prize for Innovation in Citizen Science
- Department of Industry, Innovation and Science Eureka Prize for Science Journalism

School Science

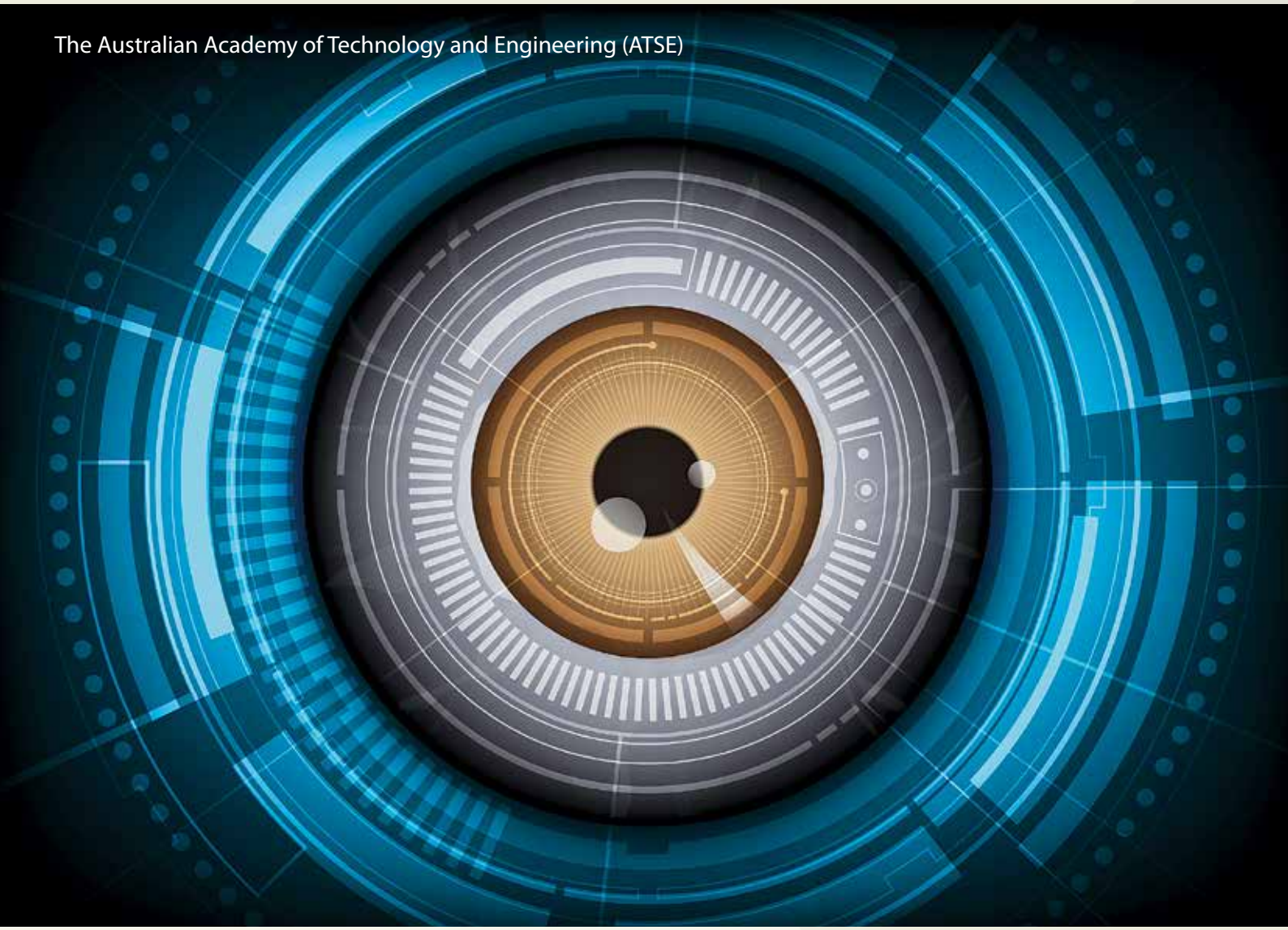
- University of Sydney Sleek Geeks Science Eureka Prize (Primary and Secondary School)

Finalists will be announced on 28 July and winners on 30 August.

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

BY DOREEN THOMAS, ROBIN KING, JOHN RICHARDS AND IAN CAMERON
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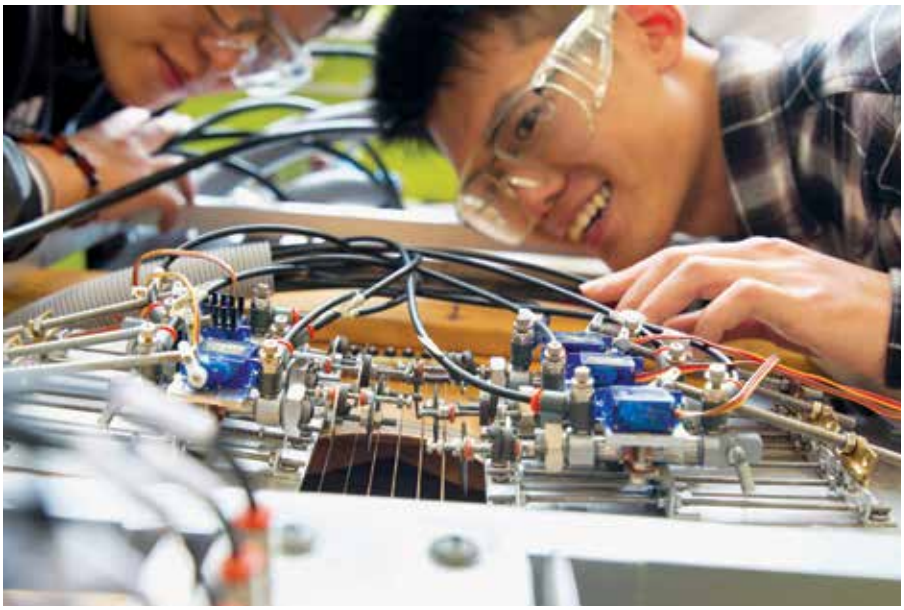
How we are educating tomorrow's engineers

ENGINEERING OUR FUTURE Higher student numbers and big changes in Australia's engineering enterprises have made it difficult for students to obtain quality industry experience before graduation.



This robot plays guitar for students.

The foundations of engineering education are laid in high school. ATSE has recognised this in two recent forums held on STEM education. The first looked at what makes an inspirational high school science and mathematics teacher. Such teachers should be highly skilled, discipline experts, confident in their subject mastery. The more recent forum explored the need, at the tertiary level, to inspire creativity though curriculum design, professional skills and engaging diversity.

One of the exciting things about engineering is its engagement with an unpredictable future. New fields and technologies emerge unexpectedly and universities must continue to educate for such emerging futures. They must produce engineering graduates who have the self-confidence to know that they can solve problems that presently can't even be conceptualised.

Australia's last review of engineering education, led by the Australian Council of Engineering Deans was in 2007, supported by ATSE and Engineers Australia. At the time there were graduate shortages at all levels of the engineering team (professionals, technologists and technicians).

Focusing on the programs to prepare graduates to enter practice, the report recommended actions to raise the public perception of engineering, refine graduate standards, increase diversity, implement best-practice education, improve the resources for engineering education and to have more effective engagement with industry.

Over the decade since that review, entry-to-practice graduations by domestic students have increased by about 30 per cent (to about 8000 in 2015), alongside increasing numbers of international students.

The curriculum is more explicitly focused on outcomes defined by employers and the professional bodies. Graduate employment rates and starting salaries for engineers have continued to be high. Many graduates are successfully employed in a wide range of occupations outside engineering, often on the basis of the quantitative problem solving and teamwork skills developed during their degrees.

Increased student numbers and profound changes in Australia's engineering enterprises have made it increasingly difficult for students to obtain good quality industry experience prior to graduation.

New modes of industry engagement are under consideration, with more students likely to seek careers in small businesses than in the past. Graduates are generally rated well by employers, while needing further development of business understanding and skills in teamwork and communication. Rarely is their basic technical competence questioned.

While commencing enrolment trends continue to be positive, participation by women has remained around 15 per cent overall for more than a decade, although is near parity in bio-related fields and around 30 per cent in environmental engineering.

FIRST-CLASS RESOURCES

The physical resources for engineering education in many of Australia's universities are first-class, with increased provision of studio and project spaces. These support student-centred learning, exemplified by problem and project-based learning, well-managed group work and flipped classrooms. Most degree programs are introducing

Food science engineers test the vintage.

Catherine Phillips, mechanical engineer.

self-reflection tools to assist students to understand and contextualise their learning.

Educators are absolutely crucial for driving innovation in future engineering education.

Complicating the scene has been a rapid change in academic demography over the past 30 years. This has seen a decrease in the number of educators who are not only excellent researchers but also possess industry experience beyond academia. This is unlikely to change in the face of an academic reward system that finds it hard to truly consider educational innovation as a mark of academic and institutional impact.

Nevertheless, most Australian engineering faculties now have small groups of engineering education experts who are leading and supporting educational best-practice and experimentation. They bring informed understanding from learning sciences, to yield significant gains in course and curriculum design. Through collegiality and teamwork they are able to support others and partly compensate for increased student–staff ratios, maintaining education standards to national and international accreditation standards.

Research and thinking on education for tomorrow's engineers emphasises that engineering is a profession in the *service* of humankind.

Future challenges for engineers will be increasingly complex. Ultimately, successful engineering has to be valued by individuals, organisations and society at large, while the engineering science and technology are embodied in physical and information infrastructure, systems, products and software.

Doing engineering is highly collaborative, and its practitioners require interpersonal and communication skills of high order. This suggests that the engineering curriculum must expand the human and social dimensions of engineering, but not at the expense of scientific and technological rigour. The curriculum must convey the nature of engineering practice and encourage students to develop their self-confidence and self-efficacy in their transformation from 'student engineers' to 'graduate engineers'.

Their education should offer increased opportunities to undertake creative interdisciplinary learning experiences. A more even balance of curriculum between the social and the technical will also contribute to an improved gender balance of the profession. The challenge is to be risk-taking, experimenting with new educational models and curriculum structures that address future graduate engineering attributes.

FUNDAMENTALS

Alongside these imperatives, students' time at university is their only opportunity to immerse themselves in the fundamentals. They need to develop a thorough understanding of the first principles of their discipline, because that is what will allow them to tackle the unknowns.

The engineering curriculum needs to be rigorous and intellectually challenging. It needs to include practical, hands-on experiences, not least to compensate for students' limited prior experience of making things. By attempting to design and build, being allowed to learn from their mistakes and risk failure (but in a risk-free environment), students learn creativity and entrepreneurship, and gain competence in applications skills.

Other demands on the curriculum include an increased focus on the sustainability of engineered outcomes and stronger capabilities in systems thinking and design, as well as new materials and data-driven methods. There are calls for more explicit connections and pathways to innovation and research, to better support Australia's declared aims as an innovation-led economy.

Can Australian universities deliver a comprehensive professional engineering curriculum enhanced in these ways within the current four-year and five-year models? How should the many competing objectives be balanced? Should there be a clearer diversity of educational outcomes and pathways, amongst the 35 Australian universities that currently graduate professional engineers?

We need to seriously question whether we can do better in both the higher education space, and in the preparation in school.

Compared to the situation 30 or more years ago, the fields of engineering have all

AUSTRALIAN UNIVERSITIES RANK HIGH AS 'INTERNATIONAL'

Australian universities have been highly rated in a new 'international' ranking of world universities, with five claiming top 25 positions. The *Times Higher Education*'s ranking of the most international universities, a new measure that takes account of the proportion of international staff and students and the strength of international reputations and cross-border research collaborations, has overturned the more prominent rankings.

The Australian institutions were the Australian National University (7), the University of NSW (14), the University of Melbourne (18), Monash University (21) and the University of Sydney (24). No other Australian universities ranked in the top 150.

The leading international universities were institutions in Britain, Australia and other centres where English is the national language or widely spoken.

Swiss institutions ETH Zurich and the Federal Polytechnic School of Lausanne claimed the top two places, followed by the University of Hong Kong and National University of Singapore, then Imperial College London. UK heavyweights Oxford (6), Cambridge (8), University College London (9) and LSE (10) rounded out the top 10, with ANU.

The top 20 also includes institutions in Canada and France, but none in the US. Massachusetts Institute of Technology was ranked 22, followed by Harvard (33), Stanford (36) and Princeton (37).

grown enormously through the explosion of research and collective knowledge. This explosion of knowledge and the expectations on an engineer are a challenge for educators.

Fitting it all into four years is a challenge and many Australian universities are exploring five- year programs. Entry-to practice Masters degrees are being offered, although their uptake by domestic students is low, except at the two universities that no longer offer the Australian standard undergraduate four-year BE(Hons) professional engineering degree.

Perhaps, more than any other profession, engineers (in all occupations and disciplines) know that the science, materials, tools and methods they use, and the problems they solve at the start of their careers will change, not least because of the work of engineers.

Their initial education must prepare them for lifelong learning. In the past, much of this has been through experience rather than formal study. Keeping up to date may, in future, require graduates to engage more deeply and more often in formal education. This is most likely to be online, and offers increased opportunities for engineering faculties.

The emphasis on the education of professional engineers is crucial, but for engineering to thrive in the economy, good education and training for engineering technologists and technicians must also be provided.

These roles – and the educational pathways to them – have been seriously downplayed in Australia over the past two decades. New thinking about their importance and profile is needed in order to ensure Australia can deliver top quality engineered products and services into the future.

Australian university engineering education has been examined in each of the past three decades. Why should it merit such attention? Largely because by its nature the future of the engineering profession keeps changing. It is classically a discipline that creates change and thus must adapt to change.

Against the enduring and essential scientific fundamentals, engineering education programs need to be reviewed regularly to ensure they meet both contemporary needs and address the constraints posed by school education.

With the time constant of technology change, now is the appropriate time to consider undertaking a further national review of engineering. ⊙

Professor Doreen Thomas FTSE is Head of the School of Electrical, Mechanical and Infrastructure Engineering in the School of Engineering, University of Melbourne. She has engineering and mathematics degrees and has applied her mathematical research in network optimisation to applications as diverse as the bionic eye, infrastructure for electric vehicles and underground mine design. She is the director of a start-up company, MineOptima, through which her mining software has been commercialised. She has been recognised with a national teaching award for her contribution to engineering education and mentorship and is a passionate ambassador for women in science and engineering. She chairs ATSE's Education Forum.

Professor John Richards AM FTSE is an engineering graduate of the University of New South Wales. He was most recently Master of University House, Australian National University. He was previously Deputy Vice-Chancellor and Vice President of ANU, and Dean of the College of Engineering and Computer Science. He is an Emeritus Professor of both ANU and the UNSW.

Professor Robin King FTSE is an Adjunct Professor at University of Technology Sydney and an Emeritus of the University of South Australia, where he was Pro Vice-Chancellor for IT, Engineering and the Environment (1998 to 2007). A communications engineer educated at Sheffield University and Imperial College, he has worked in universities in the UK, Papua New Guinea and Australia. He led national engineering education projects for the Australian Council of Engineering Deans and was their Executive Officer 2008–13. He is the past chair of Engineers Australia's Accreditation Board and of the Sydney Accord. He chaired ATSE's Education Forum in 2014–16.

Professor Ian Cameron FTSE is Professor in Chemical Engineering at the University of Queensland. He obtained his PhD from Imperial College London in process systems engineering. He has spent the past 30 years in research, consulting, teaching and learning innovation and has received numerous awards including the John A Brodie medal from Engineers Australia and the 2003 Australian Prime Minister's Award for university teaching. Over a period of 15 years with major Australian and international organisations he held roles in process and control system design, plant commissioning, risk management, production management and environmental protection. He is Deputy Chair of ATSE's Education Forum.

The façade of the 'Europa-Haus'.

ARE 3D PRINTED HOUSES NEXT?

Architects and engineers have combined their skills to start us along the road to 3D printed houses.

The façade of the 'Europa-Haus' in the Amsterdam Marine Quarter, built for the duration of the Dutch Presidency of the EU, was partly constructed in this way.

Based in Amsterdam, DUS Architects realised the idea of building entire houses in this way – with a mobile 3D printer in extra-extra-large (XXL) format, which is housed in a shipping container.

The load-bearing structures are manufactured from biodegradable plastic, which can be recycled at the end of the presidency, with obvious eco-friendly and sustainability advantages. The interior decorations, such as the seating elements, were also 3D printed.

The structural elements of the façade were 3D-printed, and then concreted into position on-site – an approach that could have implications for building new homes in disaster areas.

The printer used can print structural elements of up to 6.5 metres.

BY BRONWYN EVANS
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Broad horizons on offer for engineers

ENGINEERING OUR FUTURE Engineers are creating the technical infrastructure that will allow innovation to flourish and make communities safer by maximising efficiency and safety and minimising risk.

To look at where engineers can and do end up I want to go back 95 years to 1922 – the year Australia's national standards body (now Standards Australia) was founded. I want to do this to allow me to chart the parallel rise and change in the domains where standards are developed and the domains where engineers end up.

In October 1922 the *Commonwealth of Australia Gazette* announced the formation of the Commonwealth Engineering Standards Association. In the 1922 Year Book the export statistics tell the story of the Australian economy at the time – 51 per cent of exports were going to the UK and 75 per cent of these exports to the UK comprised butter, wheat and wool.

However, the economy was in transition from agriculture to industry with the possibility of mass production and precision engineering. As a result, the standards developed back in 1922 were clustered around supporting manufacturing products, especially taking into account concepts like the interchangeability of parts and economic efficiency.

At that time the role of the engineer could easily have been described by the current US Accreditation Board for Engineering and Technology (ABET) definition of an engineer. In this definition of an engineer, ABET posits that "*engineers creatively apply scientific principles to design or develop structures, machines, apparatus, or manufacturing processes, or works utilizing them singly or in combination; or to construct or operate the same with full cognizance of their design; or to forecast their behavior under specific operating conditions; all as respects an intended function, economics of operation or safety to life and property*".

Bronwyn Evans addresses ISO Week in Korea.

A comprehensive catalogue of where engineers would have been found in 1922 and can still be found in 2017. Indeed, these are all interesting, worthwhile and meaningful places for engineers to end up.

However, there are new horizons that are opening up for both engineers and standards bodies by virtue of the changes that are happening so rapidly in our communities, in our industries and in our economies.

In the standards development world Standards Australia has taken a role leading the international standards community into new horizons.

Standards Australia, together with the Australian business community, has advocated for international standards in blockchain, or distributed ledger technologies. This decentralised, cryptography-based solution has the potential to redefine transactions by removing the need for middlemen.

This technology is still emerging but its applications are likely to cover: financial services; consumer products and services; health; government; minerals and precious stones; real estate; internet of things; and clinical trials.

As with any emerging technology, the freedom for blockchain developers to be innovative and for vendors to be competitive is critical. In this instance standards will have a role to play in establishing market confidence to support the roll-out of the blockchain technology.

CONTINUED ON PAGE 24

BY ALEX ZELINKSY
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Partnerships powering future Defence capability

ENGINEERING OUR FUTURE

Soldiers examine equipment developed under the Diggerworks program.

Analysts worldwide recognise that science and innovation are delivering 'game- changing' outcomes for a nation's defence capabilities. While many such outcomes were realised in past centuries by brilliant scientists working alone, those days are long gone.

Nowadays, the breakthroughs come from the efforts of many engineers and scientists working in a wide range of disciplines in a multitude of organisations located across the globe.

The development of future defence capabilities today depends on the ability to form research partnerships across institutional and national borders.

This reality was recognised in the 2016 Defence White Paper that identified partnerships between Australian industry, universities and government research organisations as integral to the delivery of innovative solutions for Defence needs.

Defence Science Technology (DST) adopted this approach in earnest during 2013 when its five-year Strategic Plan was developed. Partnerships and collaboration with industry and universities have been central to our external engagement drive ever since.

Long-term strategic alliances were forged with industry primes and research agencies on the basis of co-investment and co-development of Defence capabilities, a departure from the traditional client–contractor relationship. As a result, we now have 14 strategic industry alliances in place with 32 projects currently in train.

Strategic alliances are complemented by collaborative research agreements with large companies as well as small-to-medium enterprises to leverage their expertise in exploring niche capabilities.

In recent months we have entered into agreements with: Siemens and Queensland University of Technology to undertake research in high-temperature superconductors for naval use; Jenkins Engineering Defence Systems for the application of our light cone direction finding technology to their electronic support measures system; and Grollo Aerospace to improve the performance of its supersonic aerial target, which will provide a cost-effective means for Defence to test modern weapons.

In pursuing partnerships we have also reinvigorated our relationship with universities.

In consultation with the academic sector we introduced a new model of doing business with Defence. Called Defence Science Partnerships, it involves a single, overarching agreement which has been adopted by 32 of our nation's universities.

This award-winning framework, recognised by Knowledge Commercialisation Australasia for creative engagement in 2015, provides a stronger and expanded network of research capability to meet Defence priorities.

More than 150 agreements have been signed under the new framework and the mean processing time for the agreements has more than halved.

During the first year of operation, the funding for contracts with universities increased from $8 million to $20 million. Since July 2014 we have undertaken 235 joint research projects with 24 universities, valued at $37.6 million. We expect our business with universities will increase to $35 million this year, and to more than $50 million next year.

RESEARCH NETWORKS

A feature of our partnership approach is the establishment of university research

networks. The Defence Science Institute in Melbourne, with co-investment from the Victorian Government, has been a successful venture involving universities and industry in that state undertaking Defence research. A similar initiative has recently been adopted in South Australia and is planned for NSW.

As a result of our Defence Science Partnerships framework, innovative arrangements are being forged with universities.

One such partnership is the Human Performance Research Network established with seven universities – Canberra, NSW, WA, SA, Curtin, Deakin and Victoria – to collaborate on a $4 million project relevant to Army's capabilities such as fit-for-purpose equipment, body physiology, mental resilience and teamwork.

A related partnership in assistive technology innovation involves Melbourne and Victoria universities, which have made a significant co-investment to bring together world-class expertise in ergonomics, physiology, biomechanics and engineering for solutions to help soldiers carry body-borne loads.

The University of Technology Sydney is partnering with the Royal Australian Air Force on a methodology to support the innovation activities of Plan Jericho, which aims to create a technologically advanced, fifth-generation Air Force for Australia.

Science and technology partnerships are not focused exclusively on external relationships. As DST is the science and technology adviser to Defence, we also partner with our colleagues in the Services and the broader department. These partnerships are vital for us to deliver the capabilities Defence requires.

In recent months we have developed science and technology strategies for the maritime, land and air domains in partnership with the Navy, Army and Air Force to ensure the plans meet their priorities.

The success of this partnership approach was demonstrated in recent times with the example of Diggerworks. This was a joint initiative between Army, Capability Acquisition and Sustainment Group and the Defence Science team to deliver suitable armour and equipment to our frontline soldiers on deployment.

The traditional, time-consuming procurement method was replaced with an integrated approach where researchers, Army personnel, industry and the Defence procurement body worked together from the start to meet the urgent requirements of the warfighter.

This resulted in the deployed soldiers receiving the best possible combat equipment.

One innovation developed by the Diggerworks partnership was lightweight ceramic body armour, which was developed with the collaboration between DST, the Defence Materials Technology Centre, CSIRO and the Bendigo-based Australian Defence Apparel. As a result, Australia can manufacture ceramic ballistic plates in complex, curved shapes for use by the ADF.

More recently, Defence in partnership with a number of small companies (Micreo, Ultra Electronics, Lintek, AXIOM Precision and Associated Electronic Services) developed and manufactured the Redwing suite of innovative equipment to counter improvised explosive devices.

More than 150,000 units of these life-saving devices have been supplied to Afghanistan. Last year the Redwing equipment was awarded an innovation award from the Australian Institute of Public Administration.

Opportunities for Defence innovations are set to multiply with the implementation of the $1.6 billion innovation programs in the 2016 Defence White Paper. The Next Generation Technologies Fund, managed by DST, offers universities and industry abundant opportunities to collaborate on game-changing Defence capabilities for the future.

Nine technology areas have been identified for research and further advancement – cyber, space, trusted autonomous systems, enhanced human performance, multidisciplinary material sciences, medical countermeasure products, quantum technologies, integrated intelligence, surveillance and reconnaissance, and advanced sensors, hypersonics and directed energy capabilities.

At $730 million over 10 years, the Fund is seeking partnerships through a range of programs which include University Research Networks, Defence Cooperative Research Centres, Small Business Innovation Research for Defence, Technology Foresighting, a Defence accelerator and Grand Challenges.

Afghan soldiers inspect the award-winning Greengum device developed by DST Group to counter improvised explosive devices.

As these programs are developed proposals will be invited through the Defence Innovation Portal (www.business.gov.au/cdic).

By June 2017, the Fund will invest $16.8 million to launch these programs.

The Grand Challenges program is the first cab off the rank. A 'Grand Challenge' is a large-scale Defence or national security problem that is scientifically complex and not well-addressed by current technologies, systems or methodologies and which therefore requires new concepts or emerging technologies for a solution based on a multidisciplinary, collaborative approach.

The Grand Challenges program will drive solutions to tough problems through collaboration with the best people in academia and industry.

The first Grand Challenge is to 'Counter Improvised Threats'. Improvised weapons, not just explosive devices, continue to proliferate and arrive in various unexpected forms to confront our deployed forces. Collaborative research will be necessary to find an innovative solution to this ongoing problem.

Cyber security poses another significant challenge for Defence, governments and businesses alike. Defence and Data61 will partner with eight universities – ANU, SA, NSW, Melbourne, Sydney, Queensland, Deakin and Swinburne – to develop a strategic cyber research program.

Funding of $10.5 million over three years is being invested in this important project. Industry will benefit from the results of the research to develop cyber products for Defence as well as Australian consumers of cyber technology.

Australian universities and industry will be invited as partners to join the Defence Cooperative Research Centres (CRC) being established by the Next Generation Technologies Fund. A program in 'Trusted Autonomous Systems' will be the focus of the first Defence CRC, to achieve game-changing advances that will see future systems perform reliably in uncertain warfighting environments such as carrying out pilotless aerial missions when satellites or GPS communications are not available.

The prospects for partnerships with Defence have never been better.

Developing game-changing capabilities in a fast-moving world of technology requires mutually beneficial partnerships to leverage creativity, experience and resources (with right-brain and left-brain thinkers) that can help us arrive at a solution in less time.

For Defence, partnerships provide the route to innovate rapidly and even create solutions to problems before they come to surprise us. .

Dr Alex Zelinsky FTSE was appointed Chief Defence Scientist and head of DST Group (then DSTO) in March 2012. His scientific career has included work in computer science, systems engineering and robotics. Prior to his current appointment, Dr Zelinsky was Group Executive for Information Sciences at CSIRO, CEO of Seeing Machines (a company he co-founded to produce computer vision systems) and Professor of Systems Engineering at the Australian National University. Dr Zelinsky was awarded the Pearcey Medal in 2013 for lifetime achievement in the ICT industry and the 2015 MA Sergeant Medal from Engineers Australia.

BY JIM PATRICK
jpatrick@cochlear.com

Biomedical engineering boosts our quality of life

ENGINEERING OUR FUTURE An important part of the impact of biomedical engineering comes from the personal accounts of device recipients about how their lives have been changed.

Biomedical engineering is the application of technology to the treatment of disease or disability with a view to improving the quality of life of the individual concerned.

Treatments can be life-saving, as in the case of cardiac pacemakers; can provide enhanced function, as in the case of limb prosthetics; or they can restore senses, as in the case of cochlear implants or visual prostheses. Deep brain stimulation can stop essential tremor.

Many forms of treatment have been available for decades, with products improving as technology has evolved. Scientific studies have explored how technology can be used more effectively and clinical feedback has provided guidance as to how ease of use might be improved.

This continual development has resulted in generations of products which have provided steadily improving benefits for their recipients.

Implantable medical devices involve a diverse range of engineering and adjacent disciplines, including materials science, the study of biological responses to implantable materials, hermetic packaging of implanted electronics for long-term survival, electrode design for neural stimulation, transcutaneous power and data transmission, energy storage and reliability testing.

Recent advances in radio transmission technology now allow the monitoring of device data from remote locations and the remote control of implanted devices.

For devices that provide electrical stimulation, the setting of stimulation levels has, in the past, required feedback from the recipient to the clinician. Sensitive monitoring of the neural responses to such stimuli now means that these responses can be used to program devices, reducing the time required from expert professionals and making it possible to fit very young children who are not capable of giving reliable responses.

For medical prosthetics, recipient benefit is calculated by multiplying the improvement in the recipient's health-related quality of life following treatment by the expected life of the intervention, with benefit being expressed in Quality Adjusted Life Years (QALYs).

Devices with implanted batteries, such as cardiac pacemakers or defibrillators have relatively short lifetimes and low QALYs. Some implantable stimulators, such as cochlear implants, are powered by a transcutaneous wireless link. With appropriate design and manufacturing, the expected device life of these devices is many decades, with the extended device lifetime increasing the QALY score.

The cost of any implantable medical device is substantial, as is the cost of associated surgery and subsequent medical support. For any product to be reimbursed by health authorities, it must be cost-effective.

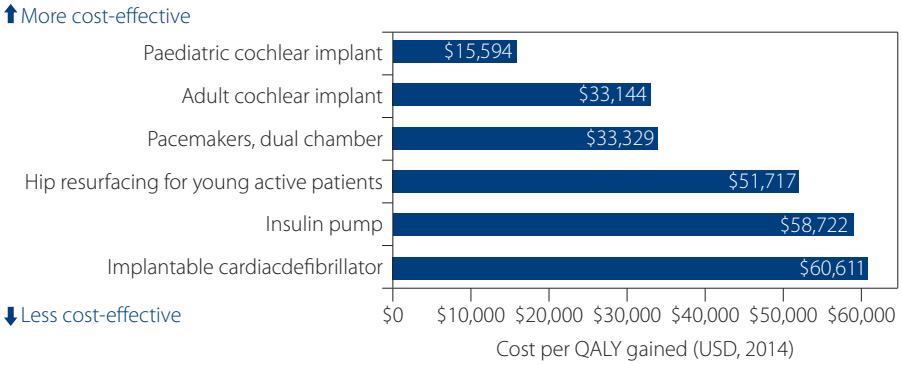
The metric used is the cost per QALY, where the total cost of the intervention is divided by the improvement in quality of life over the lifetime of the treatment.

Some examples of cost-benefit calculations are shown in Figure 1. Of the devices listed, the most cost-effective is the paediatric cochlear implant, with a cost of US$15,594 per QALY. For adults receiving cochlear implants the possible life is reduced, which reduces the cost-effectiveness.

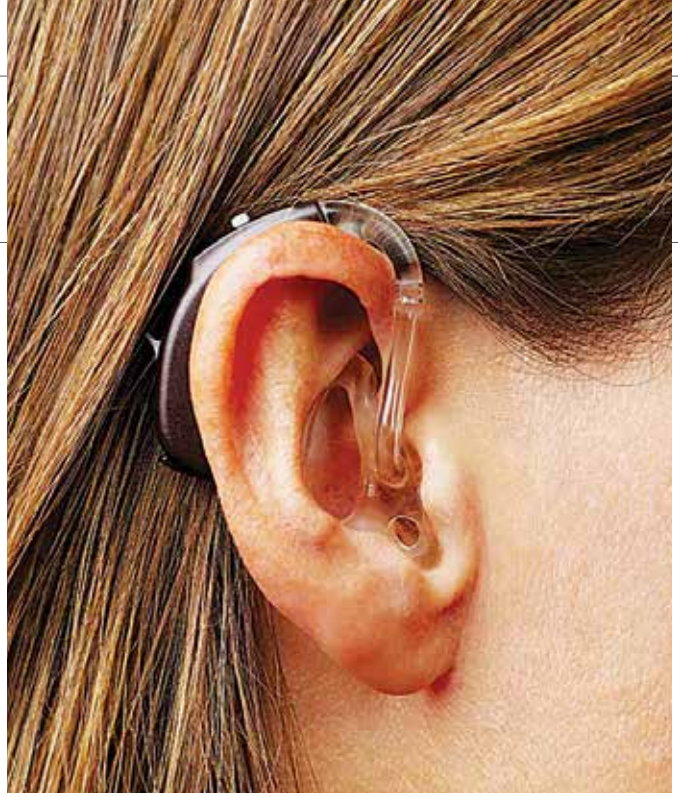
The benefit provided by a medical device can be improved by the incorporation of advanced technology. A recent example is the integration of Wi-Fi technology into implantable hearing products.

This technology now enables audio streaming from a remote microphone to a head-worn signal processor. This improves signal quality and in some situations can mean that the implant recipient can actually

Figure 1 Cost-effectiveness of various implantable device interventions.



SOURCES: BOND ET AL 2009, HEINTBERGEN ET AL 2013, ODDERSHEDE ET AL 2013, ROZE ET AL 2005, SEMENOV ET AL 2013, SMITH ET AL 2012



Engineering – helping the world to hear.

hear better than a person with normal hearing.

Potentially, there are many ways in which implantable devices can provide neural stimulation and utilise recorded activity to further improve quality of life. Research funding bodies have taken the initiative in directing research, with The BRAIN Initiative* and DARPA# funding of peripheral nerve stimulation in the US being good examples.

Such research is only possible with the development of novel technology, such as can be developed by biomedical engineers.

There is, however, no guarantee that any technological enhancement will be effective. One example is the development of distributed systems of electronics, in which semi-conductor technology is used to construct an array of integrated circuits that are linked by a common silicon substrate.

Developments in this area have been carried out over several decades but, while the use of deposited layers of hermetic material has been widely explored, the isolation of the electronic components from the ions of body fluid needed to guarantee extended product life has yet to be achieved.

The impact of contributions from biomedical engineering to medical devices is generally expressed in quantitative terms such as patient benefit and the size and growth rate of the company that is making and selling the resulting products.

For the product designers and the people involved in producing these products, however, the best understanding of the impact of their products is obtained by talking to recipients.

Their personal accounts of how their lives have been changed are remarkable – another very important measure of impact. ⊙

** The BRAIN Initiative (Brain Research through Advancing Innovative Neurotechnologies) is a 2013 collaborative, public-private Obama administration research initiative to support development and application of innovative technologies that can create a dynamic understanding of brain function.*

 # The Defense Advanced Research Projects Agency (DARPA) is an agency of the US Department of Defense responsible for the development of emerging technologies for use by the military and is responsible for some of the world's most significant scientific and technological breakthroughs.

Professor Jim Patrick AO FTSE was one of the engineers who pioneered the development of the multi-channel cochlear implant and is today recognised as a world authority on cochlear implants. Since 1981 Professor Patrick has been a member of Cochlear Ltd's senior management team, where he held a number of technology management roles, including responsibility for R&D, quality and manufacturing. He is now Cochlear's Chief Scientist-Emeritus, an Adjunct Professor at Macquarie University and an Associate Professor at the University of Melbourne. He was awarded a Clunies Ross Lifetime Achievement Award in 2015.

FROM PAGE 19

BROAD HORIZONS ON OFFER FOR ENGINEERS

This new horizon for standards development mirrors the new horizons for engineers. And in this context, the definition of an engineer as described by Australia's professional body for engineers, Engineers Australia (EA) is apposite. The EA definition says "*engineers are scientists, inventors, designers, builders and great thinkers. They improve the state of the world, amplify human capability and make people's lives safer and easier.*"

This definition boldly asserts that the boundaries for engineers are very few. This definition allows us to look to horizons way beyond our current reality, and indeed suggests that engineers can be found everywhere.

In the world of documentary standards – the world of Standards Australia, International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) – engineers play important roles as leaders, as policy-makers and as technical contributors, to highlight just a few.

By leading standards development organisations engineers are influencing international and bilateral trade relationships. They are creating mechanisms to instil market confidence and market certainty.

Put simply, in these roles engineers are creating the technical infrastructure that will allow innovation to flourish, make communities safer by maximising efficiency and safety and minimising risk.

As a case study, my role as CEO of Standards Australia allows me to be involved in every part of the economy and work with stakeholders across such diverse sectors as medical device design and manufacturing, digital hospitals, infrastructure design and construction, building information management, distributed ledger technologies, IT governance, electro-technology and much, much more.

It is the opportunity to *"improve the state of the world, amplify human capability and make people's lives safer and easier"* that motivates me to use my engineering expertise and thinking in the fascinating world of national and international standards development. ⊙

*Dr Bronwyn Evans FTSE is CEO of Standards Australia with a BE (Elec) and PhD in Electrical Engineering. She Chairs the Growth Centre for Medical Technologies and Pharmaceuticals, is a member of the Australia-Japan Foundation and is VP (Finance) of the International Standards Organisation, ISO. Dr Evans has previously held positions as Deputy Chair of The Warren Centre for Advanced Engineering and Chair of the Medical Technology Association of Australia Board. In 2014 Dr Evans was awarded the Engineers Australia President's Award, and in 2014 and 2015 was recognised as one of Australia's 100 most influential engineers. In 2016 she was named in the Westpac/*Australian Financial Review *100 Women of Influence.*

ATSE IN ACTION

Reformed NEM must meet multiple needs

Australia needs a reformed electricity market that encourages planning for the long-term needs of all consumers, large and small, that does not inhibit new technology solutions and that fully accounts for the environmental impact of electricity generation.

This is a key recommendation of the Academy's submission to the Independent Review into the Future Security of the National Electricity Market (NEM), conducted by a panel chaired by Chief Scientist Dr Alan Finkel AO FAA FTSE and including Fellows Ms Chloe Munro FTSE and Professor Mary O'Kane AC FTSE.

Many of the challenges to energy security and affordability have been caused by a changing technology landscape in the NEM, ATSE said, noting that a diverse mix of proven and emerging technologies was available to help address these challenges.

Key recommendations of the submission included the following.

1 Providing technologically neutral, market-based mechanisms to reduce emissions and maintain system security at least cost.

ATSE said the electricity market must value energy security and reliability while fully accounting for the emissions produced by electricity generation.

This would require market mechanisms to drive investment in dispatchable generation and the provision of essential system requirements, such as capacity or system inertia markets. It was also important to ensure that there were no barriers for new entrants, new technologies and new forms of services into the market.

2 Establishing a stable and unified national climate-change and energy policy based on independent, expert science, technology and engineering advice.

Policy uncertainty remained the most significant barrier to investment in the NEM, ATSE said. Clear, long-term, bipartisan policy settings were essential to ensure the investments required for transition to a secure, equitable and low emission electricity sector.

3 Establishing a body of independent experts to provide advice and guidance to optimise the transition of the NEM.

ATSE said this body would also need to address whole-of-system (generation (including emissions), transmission, distribution and demand) integration and transition challenges at a national level. Providing open access to NEM system data and models to technical experts and researchers would assist in improving transparency in the market.

4 Embracing appropriate technologies.

ATSE said these technologies for energy generation, transmission, distribution and storage must stand on their cost competitiveness, their contribution to system security and reliability, and their environmental and health impacts, including life-cycle greenhouse gas emission levels.

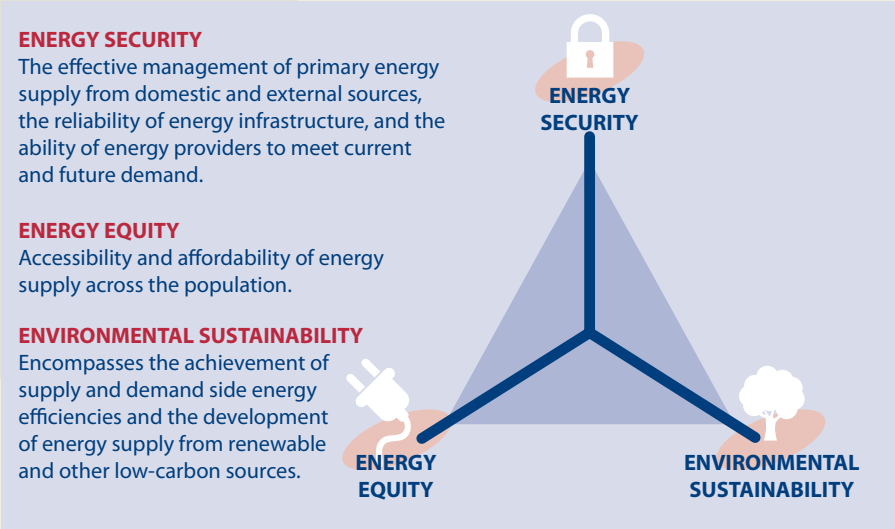
ATSE said it strongly believed that technology choice should be neutral and governed by the market. Policy and regulatory settings for the NEM should seek to incentivise the development and implementation of technologies and services that could provide balanced solutions to the energy trilemma – defined by the World Energy Council as the three core dimensions of energy sustainability: energy security, energy equity and environmental sustainability.

Australia is currently ranked 31st globally in the World Energy Council's energy trilemma index.

The submission was drafted by a working group of Dr John Burgess FTSE, Professor Simon Bartlett AM FTSE, Mr Martin Thomas AM FTSE, Mrs Else Shepherd AM FTSE, Professor Chris Greig FTSE, Mr George Maltabarow FTSE, Mr David Croft FTSE and Dr John Sligar FTSE, with input from the wider Energy Forum.

The final submission will be available on the ATSE website.

Figure 1 Balancing the 'Energy Trilemma'.



ATSE BACKS NUCLEAR SYMPOSIUM

ATSE was a major participant in an April symposium in Canberra to discuss the report of the South Australian Nuclear Fuel Cycle Royal Commission. The invitation-only symposium was organised by the Energy Change Institute of the Australian National University in collaboration with the Academy of Science, ATSE and Engineers Australia. The Royal Commissioner, the former Governor of South Australia, Rear Admiral Kevin Scarce AC CSC RAN (Rtd), framed the symposium with a summary of the Royal Commission's findings. This was followed by a series of panel discussions on key topics involving key stakeholders in industry, government, research and relevant organisations. ATSE presenters included Dr Vanessa Guthrie FTSE, Professor Ian Lowe AO FTSE, Dr Adi Paterson FTSE and Dr Erica Smyth FTSE.

ATSE IN ACTION

ATSE leads on gender equity

ATSE made another strong gender equity leadership statement when its majority-women Board met in Sydney for the first time in February.

The 10-member 2017 ATSE Board of Directors has six women – an increase of one over the composition of its Board over the past three years, when women have constituted 50 per cent of Board members.

Newly elected are Dr Rosalind Dubs FTSE (Sydney) and Dr Carrie Hillyard FTSE (Brisbane). They join Professor Kaye Basford FTSE (Brisbane), Professor Karen Reynolds FTSE (Adelaide), Professor Margaret Sheil FTSE (Melbourne) and ATSE CEO Dr Margaret Hartley FTSE. The Board is chaired by Professor Hugh Bradlow FTSE.

ATSE has a Fellowship of more than 800, of which some 11 per cent are women, and implemented a Gender Equity Policy in December 2010, which included setting a gender target of 33 per cent for new Fellows elected each year.

Women Fellows are playing a strong role in ATSE affairs. They constitute 36 per cent of ATSE's strategic forum (The Assembly), half the members of ATSE's Audit and Risk Committee, 43 per cent of the members of the Membership Committee and 36 per cent of the Clunies Ross Awards Committee. They also play a strong leadership role in ATSE's seven key Topic Forums, holding nine positions as Chair or Deputy Chair of the Forum leadership groups.

"I'm delighted to be leading a majority-women Board at ATSE," Professor Bradlow said.

"The impact of women Fellows on our endeavours has been substantial, particularly in more recent years, and even more gratifying is the rate at which new women Fellows are stepping up to take on leadership roles across the Academy."

Externally, ATSE is partnering with the Academy of Science to administer the SAGE Pilot of the Athena SWAN program, which involves 30 universities, six medical research institutes and four government science organisations.

The SAGE Pilot has adapted the UK-based SAGE program for the Australian context, running training workshops on gender equity and providing gender equity accreditation for universities, medical research centres and government research organisations that participate in the SAGE Pilot.

The program is supported by the SAGE Expert Advisory Group, formed in March 2016 and chaired by former Sex Discrimination Commissioner Elizabeth Broderick AO – ATSE's 2016 Orator – to provide expert strategic and gender equity advice.

ATSE IN ACTION

Women Fellows in top roles

ATSE marked International Women's Day in March with a media release and a flurry of tweets on Twitter noting the achievements of ATSE women Fellows and the role of women in the Academy.

Headed 'Women Fellows 'man-up' for top roles', the release said women fellows were making strong claims to top roles, rewards and jobs in Australia.

1 ATSE Director Professor Kaye Basford FTSE is a member of the Board of Trustees of the International Rice Research Institute and a Director of the Crawford Fund.

2 ATSE Director Dr Rosalind Dubs FTSE has been reappointed for a further three-year term to the Board of ASC Pty Ltd, formerly the Australian Submarine Corporation. She is former Chair of the Space Industry Innovation Council and Deputy Vice-Chancellor University of Technology Sydney.

3 Dr Bronwyn Evans FTSE has been appointed ISO Vice-President (Finance) for 2017–18 for ISO, the international standards organisation. Dr Evans is CEO of the ISO member in Australia, Standards Australia, and Chair of the Board of the Industry Growth Centre for Medical Technology and Pharmaceuticals.

4 ATSE Industry and Innovation Forum Chair and Gender Equity Working Group member Ms Kathryn Fagg FTSE is President of Chief Executive Women and a member of the Board of the Reserve Bank.

5 Dr Vanessa Guthrie FTSE, Chair of the Minerals Council of Australia, has been appointed to the Board of the ABC.

6 ATSE Director Dr Carrie Hillyard is Chairman of FizzioFit and Fitgenes and Deputy Chairman of the Mater Medical Research Institute.

7 Ms Catherine Livingstone AO FAA FTSE, former Chair of Telstra and CSIRO, is now Chair of Commonwealth Bank.

8 Professor Susan Pond AM FTSE, former ATSE Vice President, is Director of AINST (the Australian Institute of Nanoscale Science and Technology) and chairs both the Steering Committee of the NSW Smart Sensing Network and the Australian Institute of Bioengineering and Nanotechnology.

Kaye Basford

Carrie Hillyard

Karen Reynolds

Rosalind Dubs

Margaret Sheil

9 ATSE Director and Health Technology Forum Chair, 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.

10 Professor Veena Sahajwalla FTSE, Director of the Centre for Sustainable Materials Research and Technology (SMaRT) at UNSW, has just become the first woman awarded the Jubilee Chair and Professorship by the Indian Academy of Sciences.

11 ATSE Director, Professor Margaret Sheil FTSE, Provost of the University of Melbourne, is a Director of ANSTO.

12 Professor Michelle Simmons FAA FTSE, Director of the ARC Centre of Excellence for Quantum Computation and Communication Technology, recently won a L'Oreal-UNESCO Women in Science Award.

ATSE tweeted about the successes of a number of Fellows who have taken significant roles recently or taken awards.

You can follow ATSE's tweets by clicking the Twitter icon on the ATSE homepage. ATSE's Gender Equity Policy is available online (http://www.atse.org.au/Documents/About/atse-gender-equity-policy.pdf) as is ATSE *Focus* (February 2017, Issue 200) 'Women in the Driving Seat'.

ATSE IN ACTION

Pleased to be aligned with ATSE: Governor

Innovation, Industry, Trade and Investment is one of the 'lines of operation' the Governor of NSW is using in his role of engaging with the people of the state, he told a lunch attended by the Board of ATSE and members of its NSW Division in Sydney to mark his appointment as an Honorary Fellow of the Academy.

The other focus was Rural and Regional Development, Major General (Ret'd) David Hurley AC DSC FTSE told the lunch, at which he was presented with his Fellowship certificate by ATSE President Professor Hugh Bradlow FTSE.

"Within both subject areas, I am interested in understanding, supporting and promoting the use of scientific research, innovation and education. In doing so, I am particularly interested in how activities assist in wealth creation for the nation, one of the fundamental responsibilities of Government," he said.

"I am therefore very pleased to be aligned with an organisation which seeks to enhance Australia's prosperity through technological innovation."

Major General Hurley said he sought to add value for the people of NSW by providing a platform for the discussion of the 'big ideas', or drivers of change, that were shaping our world today and determining our future.

Major General Hurley

ATSE, along with the Royal Society of NSW and the other Learned Academies, has now participated in two of the annual seminars held at Government House, Sydney.

"Your eight subject areas are the right match for many of the major challenges that we face as a state and nation. Your focus on moving from innovation to production is critical as our country transforms its economy in a very competitive international environment," he said.

"There are three reasons why I think that your work is so important. One, the clock is ticking for the transformation of our economy; two, integrated and collaborative approaches are required to tackle the many complex issues that we are faced with; and three, our political leadership and opinion makers need to be engaged.

"I am deeply honoured to receive this Honorary Fellowship today and to be invited to address you at this luncheon. I thank the Board of the Academy for its generous decision to appoint me as an Honorary Fellow. I note the infrequency with which such decisions are taken and therefore value it immensely.

"Australians are indebted to the Academy for the 41 years of leadership the Academy has shown through its work in the science and engineering disciplines. To be linked to those achievements is a great honour," Major General Hurley said.

WE COULD BE A GLOBAL BATTERY LEADER

Australia has the potential to be a global leader in the deployment of domestic battery solutions, utility-scale storage solutions and the management of electricity grids, ATSE has told a Senate Select Committee inquiry into the Resilience of Electricity Infrastructure in a Warming World.

ATSE's submission says the coordination of the different supply, demand and storage systems involved would be a challenge and the expertise gained by solving these challenges would be in demand worldwide.

The storage solutions would involve concentrated solar thermal plants with inbuilt thermal storage, pumped hydro systems and utility-scale battery systems; while grid management would cover electricity grids at all scales, which incorporate energy storage with a variety of generation sources.

This would require appropriate market signals, but Australia is seen to be a test bed for the impacts of distributed storage (due to Australia's high fixed electricity tariffs and significant penetration of rooftop solar) and its world-leading electrochemistry researchers.

ATSE said there was a need to encourage even greater collaboration and coordination between researchers and industry if the Australian-developed intellectual property in batteries was to be commercialised locally.

A relevant Cooperative Research Centre (CRC) or Industry Growth Centre (IGC) for energy storage and clean energy technologies could be a potential avenue to facilitate this. Other solutions could include the development of a collaborative research hub for energy storage.

The submission noted that ATSE was participating in the Australian Council of Learned Academies' project *Energy Storage: Opportunities and Challenges of Deployment in Australia*, on the transformative role that energy storage may play in Australia's energy systems, future economic opportunities and challenges, and current state of and future trends in energy storage technologies and the underpinning science.

ATSE had undertaken extensive research and consulted with more than 50 key stakeholder organisations in the energy-storage ecosystem (including representatives from industry, business, research, government and not-for-profit organisations) for this project.

The Australian market was not substantial enough, in a global sense, to have a significant effect on costs for existing storage technologies but Australia was a beneficiary of continuing price reductions as global volumes of batteries grew significantly.

The important local issue in Australia was to minimise the financing, installation, commissioning and operating costs of energy storage systems, including the need to ensure that energy storage systems can adequately cope with the high ambient temperatures encountered across Australia during summer months, ATSE said.

The submission is on the ATSE website.

ATSE IN ACTION

STELR goes to India with top teacher

STELR teacher Dr Ken Silburn took STELR equipment to the Pitts Modern School in Gomia, India, when he visited in March, on his way to the UAE to be recognised as a top 10 finalist in the Varkey Foundation Global Teacher prize.

The Pitts Modern School (PMS) received STELR Renewable Energy Kits in 2015 with assistance from STELR principal sponsor Orica. PMS was established on 1967 by Sir Cyril Pitts, then Chair of ICI, which is now India Explosives Ltd (IEL), an Orica company.

The school remains closely associated with Orica and a number of Orica executives serve on its Board.

The Orica site in Gomia hosted Dr Silburn's visit and the site Manager, Mr Rakesh Kumar, said the PMS teachers were very excited to welcome him to their school.

"It was enormously beneficial for the PMS faculty to spend time with such an accomplished international educator and share learnings and insights," Mr Kumar said.

Dr Silburn ran a full-day workshop for teachers and spent a further two days working with both teachers and student undertaking hands-on STEM activities. PMS has set up a STELR laboratory to house the Renewable Energy Equipment kits and Dr Silburn worked with the teachers on STELR activities.

Ken Silburn working with students in India.

He also took along STELR solar cars and some other solar equipment that he delivered on behalf of STELR.

"I was amazed at the reception I got from PMS," Dr Silburn said. "I am continually impressed by the professionalism and dedication of the Indian teachers to obtaining new skills that they can pass onto their students."

Dr Silburn has made several trips to India. He participated in NASA's India Spaceward Bound Program in the Ladakh region during 2016, has delivered science workshops and training courses to Indian teachers under the auspices of the Australia India Education Council's Eminent Researcher program, and has recorded online lessons for India's National Institute for Open Schooling.

Dr Silburn teaches at Casula High School in NSW, which has been a STELR school since 2013. He has been involved with a local science teachers network, LAZSTA, and developed an enrichment program (iSTEM) for students in the local area.

He won the 2015 Prime Minister's Prize for Excellence in Science Teaching in Secondary Schools.

The Varkey Foundation is a not-for-profit organisation established to improve the standards of education for underprivileged children throughout the world. Its Global Teacher Prize is awarded under the patronage of Sheikh Mohammed bin Rashid Al Maktoum, UAE Vice President, Prime Minister and Emir of Dubai.

SEVENTY ATTEND SYDNEY STEM WORKSHOP

More than 70 delegates attended the ATSE Education Forum's successful STEM Education Workshop in February at the University of Technology Sydney (UTS).

Titled *Education for innovation – creativity, professionalism and diversity*, it addressed:

- How can educators inspire creativity through the STEM curriculum?
- What professional skills do STEM graduates need to enhance their creativity?
- How can engaging diversity improve creativity in STEM?

Speakers were: Professor Sarah Maddison, Dean of the School of Science and Professor of Astrophysics at Swinburne University of Technology; Professor Attila Brungs, Vice-Chancellor and President of UTS; and Dr Cathy Foley PSM FTSE, Deputy Director, CSIRO, and Science Director of CSIRO Manufacturing.

They were supported by an array of panellists: Professor Iven Mareels FTSE, Dean, Melbourne School of Engineering; Professor Mary-Anne Williams FTSE, Director of Disruptive Innovation, UTS; Dr Lachlan Blackhall, Co-founder and CEO, Reposit Power and 2015 Batterham Medal winner; Ms Suzanne Roche, General Manager Government and Policy, Australian Information Industry Association; Dr Sarah Pearson, CEO, Canberra Innovation Network; Dr Mark Toner FTSE, Management Consultant, Gender Matters, and Chair, ATSE's Gender Equity Forum; and Professor Robert Wood, Director of the Centre for Ethical Leadership.

Atilla Brungs addresses the workshop.

Discussion sessions were moderated by: Professor Doreen Thomas FTSE, Chair, ATSE's Education Forum; Dr Ian Cameron FTSE, Deputy Chair of the Education Forum; and Professor Elanor Huntington, Dean of Engineering and Computer Science, ANU. The event was sponsored by leading universities – UTS, Melbourne, Queensland, ANU and Curtin.

WOMEN IN TECHNOLOGY

Two Helens win ANSTO awards

Dr Helen Maynard-Casely from the Australian Centre for Neutron Scattering at Lucas Heights, Sydney, and Dr Helen Brand from the Australian Synchrotron in Clayton, Victoria, have been named winners of the ANSTO Early Career Award.

Helen Brand

Helen Maynard-Casley

Working together on planetary materials research the duo have reinvigorated the use of scattering methods in planetary materials in Australia to obtain structural data from materials under conditions that mimic the conditions on other planets.

Their award was announced at an Australian Nuclear Science and Technology Organisation (ANSTO) dinner.

ANSTO, as one of Australia's leading publicly funded research organisations, is home to about 300 researchers, many of whom are among the world's best in their field.

ANSTO CEO Dr Adi Paterson FTSE said the contribution of the organisation's researchers to the Australian and international research landscape was significant.

"The dedication they have shown to their research, ANSTO and our nation's broader research goals are to be applauded," Dr Paterson said.

GENDER IN RESEARCH

Scientific publisher Elsevier has released a new report on research performance through a gender lens, *Gender in the Global Research Landscape*, which spans 20 years, 12 geographies and 27 disciplines. Elsevier says the study draws upon a unique gender disambiguation methodology and involves global experts. Key findings include:

- between 1996 and 2000 and 2011–15 the proportion of women researchers increased in all countries and regions surveyed;
- health and life-science fields have the highest representation of women researchers;
- women's scholarly output includes a slightly larger proportion of highly interdisciplinary research than men's;
- women are slightly less likely than men to collaborate across academic and corporate sectors on papers; and
- women are generally less internationally mobile than men.

Details are on Elsevier's website (https://www.elsevier.com/research-intelligence/campaigns/gender-17).

WOMEN IN TECHNOLOGY

Gender equity is a national issue: PM

Gender equality is not just an issue for women, according to Prime Minister Malcolm Turnbull.

"It is the responsibility of all Australians, of all citizens, here and around the world, because all benefit," he told the International Women's Day Parliamentary Breakfast 2017 in Canberra.

"I want to congratulate Dr Sharman Stone on her commencement as Australia's Ambassador for Women and Girls. Sharman has very distinguished track record in Australian politics, in government and of course internationally, has been a champion for gender equality. She brings enormous experience and wisdom to this role which champions equality for women and girls on vital issues such as the elimination of child marriages, stopping the abhorrent practices of female genital mutilation and human trafficking.

Malcolm Turnbull

"Sharman continues the work of former Ambassador for Women and Girls, Natasha Stott Despoja, and we thank her for her outstanding and leadership too.

"I am proud of our ongoing commitment that at least 80 per cent of development investments, regardless of their objectives, will effectively address gender issues in their implementation. That gives an insight into our commitment on this issue.

"Our efforts internationally complement the investments we're making to empower women and girls here at home."

Women must be economically empowered, he said, noting that women's employment had reached a record high of 5.5 million.

"In the last year, 90,000 more women than men joined the workforce and we are on track to meet our G20 target of reducing the participation gap by a quarter by 2025.

"We want families to choose their child care around their work, rather than limit their work hours to suit their child care.

"The empowerment of women is the most powerful tool at the disposal of any government to keep communities strong and the economy resilient. We want more women employed as researchers, innovators, and entrepreneurs, and reaching leadership positions in all sectors of society.

"Workplace flexibility enables gender equality. It enables workers – men and women – to have a much better family–work balance.

"Very often, the barriers to flexible workplaces are simply a lack of imagination on the part of the employers. We have so much potential with technology to be able to enable greater flexibility in the workplaces.

"We have to do that and, of course, the public service should lead by example," he said.

"We are all striving for a society in which women are respected, and are on an absolutely equal footing with men, sharing equally in the corridors of power in politics and business as well as in every room in the home … gender equality is an economic and social priority for Australia.

"It's good for women, for families, for business and the economy. It is more than a theme. It should be part of us.

"By working together, we can create a society in which women are respected, represented, have a strong voice, are financially and economically secure, and are safe from violence."

> The empowerment of women is the most powerful tool at the disposal of any government to keep communities strong and the economy resilient.
>
> – PRIME MINISTER MALCOLM TURNBULL

WOMEN RESEARCHERS TAKE EIGHT AWARDS

Eight women were among the 11 winners of the $230,000 in grants awarded to 11 young scientists and researchers through the Science and Innovation Awards for Young People in Agriculture, Fisheries and Forestry.

Emily Remnant

Dr Emily Remnant, of the University of Sydney, received the Minister's award and a total of $22,000 for research into innovative ways to protect honeybees from viruses.

Dr Remnant said the symbiotic bacteria, known as *Wolbachia pipientis*, had already been shown to give virus resistance to flies and prevent mosquitoes transmitting dengue fever.

"This bacteria helps other insects fighting viruses but it hasn't been examined in honeybees yet. So I'll test the bacteria in bees and see if it helps them survive damaging viruses," she said. "It is innovative because it's using a natural chemical to prevent the viruses themselves."

The awards were presented at the ABARES Outlook 2017 conference, Australia's pre-eminent agricultural and economic conference.

Other recipients were: Dr Clare Anstead (Victoria), Australian Wool Innovation Award; Dr Caitlin Byrt (SA), Grains RDC Award; Dr Alison Carey (Queensland), Dairy Australia Award; Dr Priscilla Johnston (Victoria), Cotton RDC Award; Dr Natoiya Lloyd (SA), Wine Australia Award; Dr Kate Loudon (WA), Meat & Livestock Australia Award; and Dr Kym Patison (Queensland), CSIRO Health and Biosecurity Award.

Kym Patison

WOMEN IN TECHNOLOGY

New reports focus on key workplace issues

Two major new reports on gender equity issues identify key issues holding back women in corporate structures.

Bain & Company and Chief Executive Women's sixth gender parity study, *Advancing Women in Australia: Eliminating bias in Feedback and Promotions*, uncovers several root causes of the disparity in promotion rates inhibiting equal progress of women in corporate Australia.

The Bankwest Curtin Economics Centre and the Workplace Gender Equality Agency's latest report, *Gender Equity Insights 2017: Inside Australia's Gender Pay Gap*, highlights the persistent and perplexing 16 per cent pay gap where, among full-time workers, women earn 84 per cent of a man's pay on average.

The Bain–CEW report *Advancing Women in Australia*, based on a survey of nearly 4500 respondents from the Australian business, government and not-for-profit communities, found that women in line roles in corporate Australia are progressing more slowly than men towards leadership.

It found that almost 60 per cent of men were promoted twice or more in the past five years compared with only 41 per cent of women. This gap in promotion rates only increased with seniority.

Less than half of the female respondents (45 per cent) felt that their organisation was meritocratic, with men slightly more positive at 61 per cent.

"Merit should be assessed on performance and potential. However, defining who has merit and who does not can be open to subjectivity and bias, particularly in evaluating potential, said CEW President and co-author of the report, Ms Kathryn Fagg FTSE, who chairs ATSE's Industry and Innovation Forum.

"And if we continue to define merit as people 'like us' who have done what we did, we will get more of the same," she added.

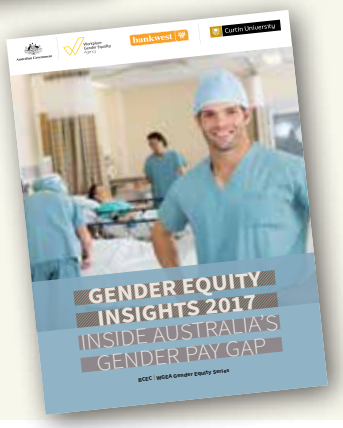
The Bain–CEW report highlighted some key differences in performance and career feedback between women and men, pointing to the perceived riskiness of female appointments:

- women were twice as likely as men to be told that they need to display "more confidence" to be ready for promotion;
- women were a third more likely than men to be told that they need "more experience" to be ready for promotion; and
- women were less likely than men to receive clear feedback on what they need to do to be ready for promotion – a disadvantage that was found to grow with seniority.

The report is the sixth in a series of landmark gender parity surveys by Bain & Company and Chief Executive Women.

It recommended actions organisations could take to improve gender diversity and business outcomes:

- train managers to provide all employees with feedback that is specific, measurable, actionable, timely and thoughtful so that women as well as men can learn about and address any performance issues in a timely fashion;
- ensure that women and men have effective sponsors to support their career development and advocate on their behalf;
- ensure that women and men have access to career-development opportunities and specific roles in which they can gain the skills and experiences deemed necessary for promotion; and
- take specific actions aimed at preventing bias in appointment and promotion decisions and processes.



The BCEC/WGEA report, *Gender Equity Insights 2017*, highlighted that 20 years ago, the full-time gender pay gap was 17 per cent, with women earning on average 83 per cent of a man's pay – an almost imperceptible improvement in two decades.

It also reveals that male graduates are more likely to access high-paying roles than female graduates.

It noted that increasing the representation of women in executive leadership roles was associated with lowering gender pay gaps. Organisations with the lowest share of female executive leaders had an average gender pay gap double the size of those with an equal share of women in senior roles – 20 per cent compared with 10 per cent.

Organisations that increased the share of women in executive leadership roles by more than 10 per cent recorded a reduction in the organisational gender pay gap of three percentage points over the course of a single year.

Overall, the median gender pay gaps for full-time graduate trainees were 2.9 per cent on base salary and 2.1 per cent on total remuneration. However, the gender pay gap for graduate trainees progressively widened among the top echelons of salary earners. The highest-paid 10 per cent of women in graduate trainee positions received at least $81,000 in base salary, whereas the highest-paid 10 per cent of male graduate trainees took home at least $88,000.

It found the average gender pay gap declined as female representation among management increased. The managerial gender pay gap fell steadily from around 15 per cent in total remuneration among firms where 20 per cent of managers were female, to eight per cent for organisations where 80 per cent of managers were female.

However, gender pay gaps were seen to rise sharply in workplaces with the highest concentrations of female managers. For organisations with a greater than 80 per cent share of female managers, the management gender pay gap rose from around eight per cent to more than 17 per cent in favour of men.

WOMEN IN TECHNOLOGY

Tanya Monro launches new mums' fund

The University of South Australia Deputy Vice-Chancellor, CSIRO Director and former ATSE Director, Professor Tanya Monro FAA FTSE, has donated $80,000 to establish a fund to make life easier for female researchers at UniSA.

The scheme, Research Momentum During Maternity Leave, which will make the $80,000 available over the next two years, is planned to be flexible and will be granted to women in response to cases being put forward for support.

The personal donation is to support researchers who are also new mothers to retain the momentum in their research.

The scheme is designed to cover a range of ad hoc expenses that will make it easier for women to manage their research commitments and the demands of a new baby.

Professor Monro, one of the world's leading experts in photonics, had three children during some of the most intensive periods of her research career.

Helping new mums.

"I understand only too well the absolute tension between wanting to keep the research on track and wanting to ensure you are giving your child everything they need in terms of care and nurturing," Professor Monro said.

"And sometimes it is the smallest supports that can make all the difference – support from a research assistant to keep vital experiments moving, a plane fare, someone to answer the phones and take care of an email backlog, a few hours of some accounting services.

"What I hope this fund will do is smooth out some of the little hurdles that slow women down at a time when they have a lot to contend with."

Professor Monro is DVC Research and Innovation and an ARC Georgina Sweet Laureate Fellow. She was the inaugural Director of the Institute for Photonics and Advanced Sensing (IPAS) (2008–14) and the inaugural Director of the ARC Centre of Excellence for Nanoscale BioPhotonics (CNBP), both at the University of Adelaide.

She is a member of the Prime Minister's Commonwealth Science Council (CSC) and the SA Economic Development Board, as well as CSIRO. She is an inaugural Bragg Fellow of the Royal Institution of Australia, won the 2015 Eureka Prize for Excellence in Interdisciplinary Scientific Research, the 2014 Beattie Steel Medal of the Australian Optical Society and the 2012 Pawsey Medal.

In 2011, Tanya was named SA's 'Australian of the Year' and the Scopus Young Researcher of the Year. In 2010, she became SA Scientist of the Year and Telstra Business Women of the Year (in the Community & Government category). In 2008, she won the Prime Minister's Malcolm McIntosh Prize for Physical Scientist of the Year.

MAGGIE NAMED ON HONOUR ROLL

IMNIS's Dr Marguerite Evans-Galea was named among 25 women inducted into the Victorian Honour Roll of Women, celebrating contributions made to local communities and achievements from human rights advocacy to sport and medicine.

Each year, the Honour Roll celebrates exceptional women in Victoria who have made significant and lasting contributions to their local community, the nation or the world. The 2017 inductees will join more than 600 remarkable women named in the Honour Roll since it commenced in 2001.

Marguerite Evans-Galea

Dr Evans-Galea is the inaugural Executive Director of the Academy's Industry Mentoring Network in STEM (IMNIS) program, which links PhD students in STEM streams with industry-based mentors. She was the founding Chair of the Early-Mid Career Researcher (EMCR) Forum with the Australian Academy of Science, and is currently a member of the Science in Australia Gender Equity (SAGE) Expert Advisory Group, Chair of the Australian Science and Innovation Forum, and Co-Founder of Women in STEMM Australia.

This year's inductees include Dr Christine Tippett, a specialist in high-risk obstetrics, businesswoman Hana Assafiri, media personality and UNICEF Ambassador Carrie Bickmore, the first woman to coach in the AFL Peta Searle and the late Stella Young, activist and comedian who challenged the way Australians view disability.

RACHEL WATSON CHAIRS CEC

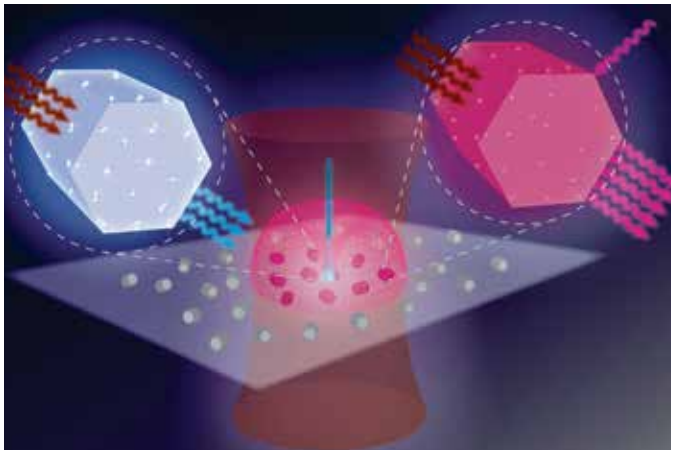
Clean Energy Council (CEC) Director Rachel Watson is the organisation's new Chair, while Megan Wheatley from Senvion and Jenny Paradiso from Suntrix have joined the CEC Board.

Ms Watson, a lawyer, is General Manager, Group Services at Pacific Hydro, which has a portfolio of more than 300 MW of operating wind and hydro power facilities. She has been with Pacific Hydro since 2006 and earlier worked for Mitsubishi Heavy Industries in Japan, negotiating power system supply contracts in many different countries, and for Orica Ltd in Australia.

Ms Paradiso is Managing Director of Suntrix, a South Australian-based solar photovoltaics company she established in 2009. She is a regular speaker at renewable energy conferences and has worked in management roles for more than 15 years. In 2016 she won the National Telstra Business Women's Entrepreneur Award.

Ms Wheatley is Manager of Communications and External Affairs for Senvion Australia, which has 440 MW of wind capacity installed across nine wind farms in Victoria and NSW. She has worked in energy and sustainability in Australia and internationally for almost two decades.

NEWS



Seeing images at super resolution.

Super-resolution optical microscopy breakthrough

An Australia–China research team has made a breakthrough in the development of practical super-resolution optical microscopy that they say will pave the way for the detailed study of live cells and organisms on a scale 10 times smaller than can currently be achieved with conventional microscopy.

The team – from the ARC Centre of Excellence for Nanoscale BioPhotonics (CNBP) at Macquarie University, the University of Technology Sydney (UTS), Peking University and Shanghai Jiao-tong University – has demonstrated that bright luminescent nanoparticles can be switched on and off using a low-power infrared laser beam, and used to achieve images with a super resolution of 28 nanometres (nm).

The scientific breakthrough, which uses luminescent nanocrystals with the chemical element thulium added at high concentration, involves creation of a unique excitation condition whereby the signals can be optically modulated via either spontaneous emission pathway or stimulated emission pathway.

Professor Jim Piper, leader of the research team at Macquarie University and the ARC Centre of Excellence for Nanoscale BioPhotonics (CNBP), sees these nanoparticles as having new, unique properties.

"These allow researchers to see well beyond normal limits of standard microscopes," Professor Piper said. "It will let you see deeper and more clearly at the cellular and intra-cellular level – where proteins, antibodies and enzymes ultimately run the machinery of life."

The use of nanoparticles for bioimaging is a relatively recent development that has attracted widespread attention internationally. Typically, the nanoparticles are placed in biological samples and then excited by the lasers of a confocal microscope. The nanoparticles act as tiny lamps which show where they are located. However, fundamental limitations of light restrict the minimum size of images to about 200nm, insufficient to visualise many biological structures of interest. By contrast this research shows that nanoparticles down to 13nm, possibly even smaller, can be visualised in a new form of optical nanoscopy where unwanted luminescence is suppressed by a low-power infrared laser.

"A particular problem of current 'stimulated emission depletion' microscopy is that high laser power is required to suppress emission from normal dyes and this can damage the biological samples that we are trying to look at – obviously not ideal when trying to make a diagnosis," Professor Piper said.

"Our nanoparticles are unique in that luminescence can be amplified and modulated with commonly available low-power semiconductor lasers.

"What we've done is illustrate that tiny nanoparticles offer substantial potential as a new generation of luminescent probes for optical nanoscopy. This opens up an entirely new avenue in the study of live biological processes in greater detail, to ultimately help us to understand how the body works at the nanoscale – this is the key goal of the CNBP."

CNBP is led by the University of Adelaide, with research-focused nodes also at Macquarie University and RMIT University. A $40 million initiative, CNBP is focused on developing new light-based imaging and sensing tools that can measure the inner workings of cells in the living body.

UNISYS AND DATA 61 GUARD OUR BORDERS

Unisys Corporation and CSIRO's Data61 are collaborating to develop an advanced data analytics solution for automated security risk assessment of travellers and cargo at air, land and sea borders.

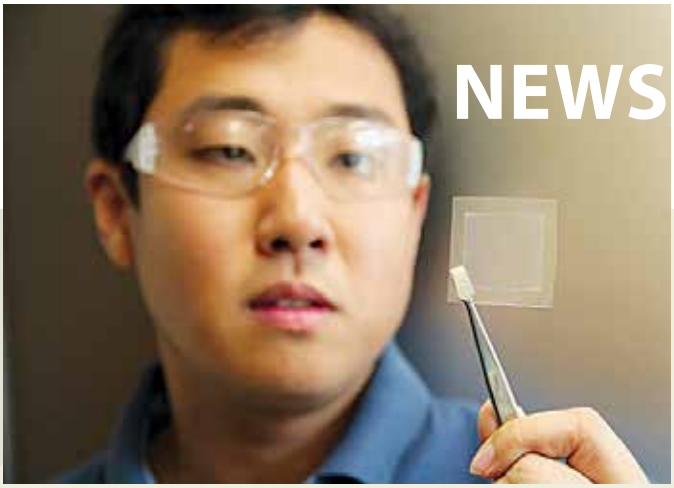
Under the collaboration, Unisys will fund joint research with Data61 to develop an advanced data analytics solution capable of detecting potential border security risks, which will build on Unisys' existing large-scale border security analytics capability to offer as a repeatable solution available to governments globally.

The research involves assessing anonymised data sets from airlines using analytics and machine learning to identify patterns that indicate potential risks of both traveller intent and cargo contents.

Unisys works with governments worldwide to secure their air, land and sea borders and facilitate the movement of people and goods, with clients including the Australian Department of Immigration and US Customs and Border Protection.

"Unisys' deep domain expertise and global reach combined with Data61's analytics and machine learning capabilities provides a unique opportunity to advance border security technology around the world during a time of increasingly sophisticated threats and greater dependence on international travel and cargo shipments," Unisys said.

"This will allow border agencies to automate the processing of low risk people and cargo while reserving specialised border security resources for the small percentage of travellers and cargo that present a higher risk profile."



Dr Dong Han Seo holds a piece of graphene film.

Making graphene from soybeans

A breakthrough by CSIRO-led scientists has made graphene, the world's strongest material, more commercially viable, thanks to the humble soybean.

Until now, the high cost of graphene production has been the major roadblock in its commercialisation. Previously, graphene was grown in a highly controlled environment with explosive compressed gases, requiring long hours of operation at high temperatures and extensive vacuum processing.

CSIRO scientists have developed a novel GraphAir technology, which they say eliminates the need for such a highly controlled environment. GraphAir transforms soybean oil – a renewable, natural material – into graphene films in a single step. The technology grows graphene film in ambient air with a natural precursor, making its production faster and simpler.

"Our GraphAir technology results in good and transformable graphene properties, comparable to graphene made by conventional methods," CSIRO scientist Dr Dong Han Seo said.

With heat, soybean oil breaks down into a range of carbon building units that are essential for the synthesis of graphene. The team also transformed other types of renewable oils and even waste oil, such as that leftover from barbecues or cooking, into graphene films.

Graphene is a carbon material that is one atom thick. Its thin composition and high conductivity means it is used in applications ranging from miniaturised electronics to biomedical devices. These properties also enable thinner wire connections – providing extensive benefits for computers, solar panels, batteries, sensors and other devices. The potential applications of graphene include water filtration and purification, renewable energy, sensors, personalised healthcare and medicine. Graphene has excellent electronic, mechanical, thermal and optical properties as well. Its uses range from improving battery performance in energy devices, to cheaper solar panels.

CRCS FOR FOOD, SOIL, BEES AND TRAFFIC

The Government has committed more than $151 million for four new Cooperative Research Centres (CRCs) in food, soils, honey bees and traffic technologies.

A new CRC for High Performance Soils will receive nearly $40 million over 10 years to help farmers bridge the gap between soil science and farm management.

The CRC for Honey Bee Products will get $7 million over five years to help link unique floral hive sites to product quality control processes.

A new Food Agility CRC will help Australia's food industry grow its comparative advantage through digital transformation with $50 million from the government over 10 years.

The iMove CRC, which will receive $55 million over 10 years, will explore digital and evolving vehicle technologies to help traffic to flow more smoothly.

The new CRCs selected in this 18th funding round would involve interdisciplinary researchers working with industry to explore new processes, including digital technologies, to deliver improvements in strategic industry sectors, said Industry, Innovation and Science Minister Senator Arthur Sinodinos AO.

SYDNEY SHOWCASES NEW SENSING TECHNOLOGIES

Futuristic sensing technologies to tackle major challenges in agriculture, health, security, the environment and industry were showcased today at the official launch of the NSW Smart Sensing Networking (NSSN) in Sydney in February.

NSSN Steering Committee Chair, Professor Susan Pond AM FTSE, hosted the event, which was addressed by NSW Chief Scientist and Engineer Professor Mary O'Kane AC FTSE and Network Co-Directors Professors Benjamin Eggleton FAA FTSE (University of Sydney) and Professor Justin Gooding (University of NSW).

Some of the projects/technologies on display at the launch included:

- biomedical research led by Professor Gooding to detect clinically important biomarkers in blood; pioneering work into UV-sensitive skin patches and sensors;
- water quality research led by UNSW's Dr Alex Donald into developing a palm-portable device to monitor toxic pollutants in NSW central coast groundwater that led to a fishing ban;
- air-sensing research led by Professor Eggleton in a variety of photonic techniques sensing gases and particles in the atmosphere;

Dr Parisa Sowti Khiabani wearing a UV-sensitive skin patch developed at UNSW.

- wildlife-sensing capabilities led by Dr Zhe Xu, from the Australian Centre for Field Robotics, to monitor iconic and ecologically important species; and
- wearable polymer research led by the University of Sydney's Professor Simon Fleming to sense changes in the body, such as the movement of bedridden patients, bandage pressure and to measure metrics of elite athletes.

NEWS

Take SAGE into high schools

The future depends on our STEM disciplines. We know that the Chief Scientist and the Prime Minister are both, rightly, committed to the growth of participation of women in the STEM disciplines.

Yet, in spite of a growing population, the number of girls studying Unit 4 physics to Year 12 in Victoria is dropping. At the same time, the number of boys studying the subject is increasing. In 2001 there were 2.8 boys to each girl; in 2015 this had increased to 3.8 boys to each girl.

This is even more concerning given that mathematics and physics play a key role in opening up career opportunities, even if the ultimate aim is not to actually pursue a career as a physicist or mathematician.

Discouraging girls from studying maths and physics to Year 12 bars them from rewarding careers in disciplines such as engineering and computer science, not to mention other emerging areas around social science, cybersecurity, psychology and bioinformatics that depend on big data, analytical skills, physics and mathematics.

Some areas of STEM have no problem attracting women. Many fields of biology have a majority of women studying them at the high school, undergraduate and postgraduate levels. Sadly, the senior professional levels of these disciplines do not show the same balance and remain dominated by men.

This is why programs such as the Athena SWAN program and the Science in Australia Gender Equity (SAGE) programs are so important: they identify the loss of talent with seniority in professional areas – primarily the biosciences – that start out with such promise. Addressing this structural problem is urgent and Australian scientific bodies need to pay urgent attention. And, with the support of the Australian Academy of Science and the Australian Academy of Technology and Engineering through the SAGE program, they are starting to.

It seems to me that the problem with physics is different and distinct. For these disciplines, the fraction of women starts low and stays there. The problem is different and therefore so is the solution.

The issue for physics and mathematics therefore resides at the primary and high school level. Arguably, we elect to put girls through such an unappetising time in school physics and mathematics that only the most committed make it through to higher levels at university. It is a problem that we, as a community, need to fix. But the SAGE program won't do it.

Keith Nugent

We need a kind of SAGE program in high school. Programs such as Growing Tall Poppies (GTP) (see: http://www.growingtallpoppies.com/) are precisely what is needed, but programs like GTP need to be done systemically and systematically. That is still not happening.

How can we, as a community, stand by and accept that it is OK for the number of women studying physics to year 12 to continue to decline? Why should we care?

To paraphrase Justin Trudeau – because it's 2017.

I think it is a scandal, and it underlines the deep importance of developing programs like GTP that have the explicit goal of encouraging girls to study physics to Year 12 and to do so without compromise.

– PROFESSOR KEITH NUGENT

Professor Keith Nugent FAA is Deputy Vice-Chancellor and Vice-President (Research) at La Trobe University and a Professor of Physics at the University of Melbourne, specialising in X-ray optics and near-field optics. He co-founded the Growing Tall Poppies program with Dr Eroia Barone-Nugent. It is currently funded by the Australian Mathematics and Science Partnership Program.

NINE WIN SCIENCE AND ENGINEERING AWARDS

Nine students have been chosen from among 26 finalists as winners of the 2017 BHP Billiton Science and Engineering Awards.

A beach-side rip warning system, a laser system to keep cyclists safe on roads, and research into treatments for diabetes and antibiotic-resistant bacteria were just some of the projects evaluated in the awards.

The winners were:

- Engineering Award – Justin Mitchell from Victoria (first place), Callum and Declan Predavec from New South Wales (2) and Dylan Sanusi-Goh from Victoria (3);
- Investigations Award – Jade Moxey from New South Wales (1), Amy Zhou from Queensland (2) and Rebekah Kang from New South Wales (3);
- Innovation to Market Award – Amber Kraczkowska from South Australia; and
- Teacher Award – Hamish Gibson from Western Australia.

Selected finalists will represent Australia at the Intel International Science and Engineering Fair (Intel ISEF) in the US in May.

CSIRO Chief Executive Dr Larry Marshall FTSE said it was critical to support and promote STEM (science, technology, engineering and mathematics) for students.

"STEM drives innovation globally but in Australia the participation and engagement in STEM subjects by school students is declining," Dr Marshall said.

"These Awards are an innovative and inspiring way to connect with future STEM professionals and encourage them to join us in tackling the challenges of tomorrow."

NEWS

Science literacy levels static, says report

Only two states advanced in Year 6 students' science literacy levels in the past decade, according to the fifth National Assessment Program (NAP) – Science Literacy report, released by the Australian Curriculum, Assessment and Reporting Authority (ACARA).

The report showed the balance of Australian students' achievements had remained static.

Data from the NAP – Science Literacy assessments, held in late 2015, revealed little change in national performance levels in terms of both average student achievement and the proportion of students performing at or above the proficient standard.

The proficient standard was set at a challenging level, and only just over half (55.1 per cent) of Year 6 students reached or exceeded it.

"The results show there is no statistically significant difference between the 2006 and 2015 results at the national level, or across most Australian states and territories, said ACARA CEO Mr Robert Randall.

STELR emphasises STEM in schools.

"There are two exceptions to this: Tasmania, where results are significantly higher than observed in 2009; and Western Australia, which has maintained its significant improvement from 2006 – first seen in their 2012 results.

The results highlighted the need for improvements in primary school science teaching, he said.

Other key findings of the report include:

- female students performed better than male students nationally – in 2012, female students had a higher mean than male students, but it was not statistically significant;
- as seen in previous assessments, Indigenous students had a statistically significant lower mean achievement than non-Indigenous students; and
- students from metropolitan areas had higher mean scores than students in provincial areas, who in turn had higher mean scores than students in remote and very remote areas.

Students were surveyed to determine the extent of their interest in science, their engagement in science-related activities and their understanding of how science was relevant in their lives. The results of the student survey showed that the great majority of students (more than 80 per cent) appeared to be interested in learning new things in science, learning about science and doing science-based activities.

"This is a strong foundation on which to build student awareness of the importance of science in their everyday lives, build confidence, inspire excellence and encourage students to consider rewarding future careers in the field of science," Mr Randall said.

The National Chair of the Association of Heads of Independent Schools of Australia (AHISA), Mrs Karen Spiller, said the results suggested the national focus on engaging girls in STEM subjects may be bearing fruit.

"The sample testing shows that, for the first time since sample testing began, a small but significant gender gap has emerged in favour of girls," Mrs Spiller said.

Mrs Spiller said Australia's results in the OECD's Program for International Student Assessment (PISA) confirmed that Australian girls do not experience a gender disadvantage in their academic achievement in science up to Year 10, although they may report being less confident than boys about their abilities.

However, only 29 per cent of university STEM graduates were women, she noted.

"Clearly it is girls' career aspirations and therefore their choice of senior secondary subjects that are contributing to the gender gap in STEM participation observed at tertiary level and in industry," she said.

"Schools and careers advisers are very aware that girls are likely to express more interest in careers in science-related fields if they see this work as helping others – hence the attraction of medicine – or as helping communities, cities and societies to function better and in more sustainable ways.

"Role models of women achievers in all branches of science can help build girls' confidence and aspirations.

"Schools, parents, government, academia, industry and the media – everyone has a part to play in promoting women achievers if more girls are to grasp opportunities in STEM fields

EDUCATION EXPORTS AT RECORD HIGH

Australia's excellent reputation for high-quality university education, our proximity to Asia and a lower Australian dollar helped to propel education export earnings to a record $21.8 billion in 2016 – 17 per cent more than 2015 and the strongest annual growth since 2010. The education of international students is Australia's third largest export, behind only iron ore and coal. Universities Australia Chief Executive Belinda Robinson said Australia's global outlook and excellent reputation for the quality of university education and research were key factors in the growth. The total value to Australia of international education exports could be even higher than the latest $21.8 billion figure, which does not include education consultancy services, royalties from intellectual property or income from correspondence courses.

NEWS

NEWS

ANSTO helps chase for 'superbug' cure

ANSTO's Australian Synchrotron is playing a key role in fighting superbugs.

The Synchrotron's X-ray crystallography capacity is helping researchers find insights into the ways antibiotic resistance occurs and, potentially, new treatments.

Multidrug resistant superbugs are estimated to cause about 700,000 deaths annually, ANSTO says, and that number will potentially reach 10 million yearly by 2050 according to the World Health Organization (WHO).

"The rise of multidrug resistance in bacteria has led to the dramatic increase in the number of deaths worldwide from bacterial-mediated sepsis," says researcher Professor Alice Vrielink, from the University of Western Australia.

Michael James

"At the Australian Synchrotron we used a technique called X-ray crystallography to map the three-dimensional shape of a protein, called EptA, which causes resistance to colistan, a last resort antibiotic for many disease-causing bacteria. EptA causes antibiotic resistance by masking bacteria from both the human immune system and colistan.

"Having a knowledge of the three dimensional shape of EptA will allow us to design new and effective treatments to unmask the bacteria so that it can be treated by antibiotics as well as allowing our immune system to clear the pathogen.

"These new treatments will be a huge step forward for public health worldwide," she says.

Professor Michael James, Head of Science at the Australian Synchrotron, says macromolecular crystallography allows scientists to see the structure of biological molecules such as proteins at the atomic level.

Macromolecular crystallography relies on focusing an extremely bright beam of X-rays produced using the MX2 beamline at the Australian Synchrotron, down onto a protein crystal that is a fraction of the width of a human hair – perhaps as small as one-hundredth of a millimetre.

"The X-rays diffract off the many millions of copies of the protein in the crystal, and by analysing the patterns formed by the diffracted X-rays we can determine the protein's molecular structure," Professor James says.

3D PRINTED STERNUM A SURGERY FIRST

CSIRO has teamed up with Melbourne medical implant company Anatomics and UK doctors to carry out world-first surgery to implant a 3D printed titanium and polymer- sternum into a British patient, who has made a successful recovery.

Designed by Anatomics and printed at CSIRO's Lab 22 facility in Melbourne, the sternum was implanted into 61-year-old Daniel Evans, who had previously had his sternum removed due to a rare infection. It was the first time that a titanium sternum combined with a synthetic polymer had been used to replace bone, cartilage and tissue in a patient.

The operation is the latest success story for the CSIRO-Anatomics partnership, which had previously produced a 3D printed titanium-only sternum and rib implant in 2015 for a Spanish cancer patient and an earlier (2014) 3D printed titanium heel bone that enabled an Australian cancer patient to not have his leg amputated.

"Here in Melbourne, we have quietly been developing what we believe is one of the world's most advanced capability in reconstructive prosthetics, and this recent success in the UK demonstrates that," Director of CSIRO Manufacturing Dr Keith McLean said.

AUSTRALIANS FEAR ROBOTS, SURVEY SHOWS

Up to 3.8 million (16 per cent) of Australians believe their current role will be made redundant by a robot in the next five years, a future of work study has found.

A study by research firm PureProfile, which polled a representative sample of 1003 Australians, also found that 71 per cent of the population believes the rise of the machines will replace more jobs than it creates.

The data, gathered for online outsourcing agency Airtasker, highlights the fear of automation.

The study also revealed:

- around 40 per cent of Australians see human interaction to be the main factor that will prevent more roles from being automated;
- flexibility and pay remain the most important aspects of a job for all Australian workers – for three years, 'flexibility of work' has beat out 'predictability of work' as the most appealing aspect of modern work;
- those aged between 25 and 34 are the most concerned that their job will be made obsolete by automation within the next five years – however, the same age group is also the most hopeful that machines will create new industries and more jobs than they replace; and
- of all industries, those working in education are the most optimistic that machines will create more jobs than they replace.

Airtasker is an online marketplace for people to outsource tasks, find services or complete flexible jobs – handyman work, office administration or photography, for example – by posting a task for free and then choosing from the responses.

NEWS

The Sydney Science Park concept.

City living under the microscope

In partnership with property developers Celestino, CSIRO has established its first operational Urban Living Lab at the Sydney Science Park.

The Urban Living Lab is a place where researchers, industry, government and communities can get together and create, design and test innovative urban development concepts, moving beyond the laboratory into the real world.

Within the Urban Living Lab's test environment, researchers will examine the connections between issues such as urban greening, energy efficiency, demands for water, community well-being and health and the impacts of technological advancements.

CSIRO says the research will be critical for developing and renewing cities and urban spaces to be sustainable in the face of pressures such as population changes and climate change.

Examples of research topics already under consideration include:

- the impact of increased urban greening on local temperatures and ecology, changes in energy and water demand and consumption, and the influence on community well-being and health;
- smart water systems that can efficiently provide different classes of water for different uses on demand; and
- the influence of digital disruptions and information technology advances on urban structure, industry development and community connectivity.

FLOWORKS SCORES IN CATALYST TECHNOLOGY

CSIRO scientists have made an important breakthrough that could result in faster and cheaper production for the pharmaceutical, food and bulk chemistry industries.

They have developed a more efficient and simpler process that, when combined with flow chemistry, does away with the need to filter out the catalysts that are usually added to a mixture to ensure a chemical reaction takes place and then have to be removed – an often tedious, time-consuming and costly task.

CSIRO's FloWorks Centre for Industrial Flow Chemistry used the technique to create a key ingredient in the manufacture of the antibiotic linezolid – the first successful example of a combined catalyst and flow reactor technology that could make the leap from the laboratory to industry.

CSIRO's new method involved 3D printing specially designed rods known as static mixers at Lab 22, then using its cold spray technology to coat and immobilise the catalyst onto the rods.

They were then placed inside the flow reactor, allowing reactions to occur without the catalyst leaching into the product.

CHASING MORE ACCURATE POSITIONING TECHNOLOGY

Technology companies GMV, Inmarsat and Lockheed Martin have joined Australia's two-year project aimed at dramatically improving the accuracy of positioning systems.

Geoscience Australia's Gary Johnston said that the project was trialling a Satellite Based Augmentation System (SBAS), with Australian Government funding of $12 million.

"The SBAS test-bed is Australia's first exploratory step to joining countries such as the US, Europe, China, Russia, India and Japan, which are already using the technology on a daily basis.

"This technology hasn't been widely tested in Australia before, however GMV, Inmarsat and Lockheed Martin have experience implementing it around the world.

"The testing of SBAS technology in Australia offers a number of potential safety, productivity, efficiency and environmental benefits to many local industries, including transport, agriculture, construction, and resources.

"Research has shown that the wide-spread adoption of improved positioning technology has the potential to generate upwards of $73 billion of value to Australia by 2030," Mr Johnston said.

Mr Johnston said Geoscience Australia, along with the Australia and New Zealand CRC for Spatial Information (CRCSI), was responsible for the implementation and oversight of the project, but would collaborate closely with GMV, Inmarsat and Lockheed Martin on the technical components of the test-bed.

More accurate positioning is the aim.

"We'll be testing two new satellite positioning technologies – next-generation SBAS and Precise Point Positioning – which provide positioning accuracies of several decimetres and five centimetres respectively."

Australia currently relies on the Global Navigation Satellite Systems (GNSS) of other countries including the US Global Positioning System (GPS). These international systems typically give Australians positioning accuracy of five to 10 metres.

NEWS

NSW's solar plants under way

Three big solar projects in NSW are moving into the construction phase after getting the financial green light – with construction due for completed by the end of the year.

The plants in Parkes, Griffith and Dubbo will consist of more than 400,000 panels, providing enough renewable energy to power 41,500 homes a year.

Developed by renewable energy company Neoen, the plants will also boost regional NSW economies, creating an estimated 250 jobs during construction, mostly in the local regions.

The Neoen projects are collectively receiving $16 million in funding through ARENA and $150 million in debt financing from the Clean Energy Finance Corporation.

Neoen has signed commercial power purchase agreements (PPA) with energy retailer ENGIE to sell energy from Griffith and Parkes, with the Dubbo project progressing on a merchant basis. This is the first large-scale solar PPA signed by ENGIE in Australia, adding to its existing renewable energy presence offtake of the 46 MW Canunda windfarm and representing another large energy player stepping into Australia's renewable energy sector.

ARENA CEO Ivor Frischknecht said ARENA was accelerating the shift to an affordable and secure renewable energy future for Australia by rapidly bringing down costs and leveraging private sector investment.

"The plants will cost around $2 per watt of capacity, one-third cheaper than AGL's plants in Nyngan and Broken Hill, which cost $2.8 per watt in 2014 and were competitive at the time," Mr Frischknecht said.

ELECTRICAL 'FINGERPRINT' TO BOOST ENERGY EFFICIENCY

CSIRO will partner with start-up company Ecocentric on a system that recognises the electrical 'fingerprint' of individual appliances to increase energy efficiency in buildings.

Under a licensing and research agreement, CSIRO and Ecocentric will further develop the Numen energy system, which brings together a building's total energy signal, identifies the appliances present, and then separates out appliance-specific consumption data on how much energy the appliance is using.

Developed collaboratively using CSIRO algorithms, Numen improves the processes involved in using and conserving energy in homes, commercial buildings and industrial facilities.

Where conventional smart-meter systems record low-resolution total energy use (generally for the purpose of billing), CSIRO-developed 'cognitive metering' technology identifies individual appliances using a unique signature of high-frequency electrical data. Advanced machine learning algorithms are then employed to measure appliance power consumption without the need to individually meter them.

Numen uses cloud-based technology to monitor energy consumption in real time, allowing unprecedented insights into the operation of critical machinery.

The Numen system is claimed to allow automatic identification of metered electrical devices, facilitate better understanding and prediction of energy use patterns, and predict faults for pre-emptive maintenance. CSIRO says this information will highlight opportunities for more efficient energy use, resulting in cost savings and a reduced carbon footprint.

Under the agreement, Ecocentric will obtain a licence from CSIRO to the cognitive metering technology and work with CSIRO for a period of six years to further refine the system.

CSIRO's Sam West and Ecocentric's Paul Lyons examine the Numen device.

FIRST STEP TO SOLAR/PUMPED HYDRO PROJECT AT KIDSTON

Genex Power Ltd has secured $54 million in debt finance from the Clean Energy Finance Corporation for the development of the Phase One 50 MW large-scale solar farm at its Kidston Renewable Energy Hub, 270 kilometres north-west of Townsville.

The solar farm is expected to lead to the Phase Two development of a pumped hydro storage project on the same site.

The project is based around the former Kidston gold mine. The project will be the first of its kind in Australia to co-locate a large-scale solar farm with a large-scale pumped hydro storage project, creating a combined generation and storage model that can be used elsewhere.

Genex said that with full project construction underway for Phase One of the Kidston project, it would seek to secure financial arrangements for the 250 MW Kidston pumped storage hydro project.

The Kidston project is the latest to have received finance under the CEFC's large-scale solar program, following its recent $150 million commitment to three NSW projects. Further CEFC-financed large-scale solar projects are nearing financial close, with the program on track to exceed its initial $250 million target.

Genex estimates that, on completion, the 250 MW pumped hydro storage project will support 1500 MWh of continuous power in a single six-hour generation cycle. While large-scale pumped hydro storage has a proven track record overseas, there are only three projects operating in Australia at Tumut and the Shoalhaven in NSW and at Wivenhoe in Queensland.

NEWS

We have to lift our game, says Ferris

Australia needs to significantly lift its game if it wants to be a top-tier innovation nation, according to Innovation and Science Australia (ISA).

In ISA's *Performance Review of the Australian Innovation, Science and Research System* (ISR System Review), Chairman Mr Bill Ferris AC notes that Australia is a country with incredibly talented and industrious people, which must aim to optimise its innovation potential.

"This means creating, transferring and applying knowledge to achieve a sustainable high-growth economy and protect the environment and social fabric of this great nation," he notes in the report.

"This is an important and exciting challenge. As a nation we currently spend more than $33 billion per annum on research and development and it is essential we optimise the benefits from such investments."

The Performance Review by ISA, with Dr Alan Finkel AO FAA FTSE as its Deputy Chair, was the first step in its program and a baseline for its 2030 Strategic Plan for improving and enhancing Australia's innovation, science and research system.

"My fellow board members and I hope that the ISR System Review will provide valuable insights and guidance to stakeholders during this critical evaluative period of the process," Mr Ferris says.

"ISA's mission is the realisation of an ambitious vision for Australia's future, one in which science and innovation play a central role in securing our prosperity and addressing the great challenges of our times. Australia must be ambitious in facing these challenges.

"We look forward to seeking input through broad consultation for our task ahead."

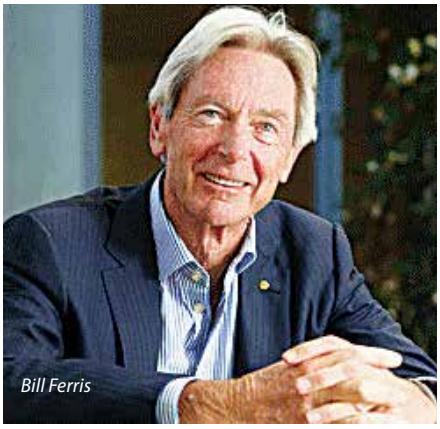
Mr Ferris acknowledges the role of the Australian Council of Learned Academies for conducting workshops and sharing valuable insights gained through the Securing Australia's Future work program.

ISA, an independent statutory body with the remit to provide whole-of-government advice on all science, research and innovation matters, was established under the Government's 2015 National Innovation and Science Agenda (NISA).

The ISA Board is also tasked with the oversight of a number of Australian Government innovation support programs, including the Research and Development Tax Incentive, the Venture Capital Limited Partnerships and Early Stage Venture Capital Limited Partnerships funding, the Entrepreneurs' Program elements, the Biomedical Translation Fund and the Cooperative Research Centres.

Speaking at a subsequent American Chamber of Commerce event in Sydney, Mr Ferris said bold action was needed to harness Australia's innovation potential in facing up to the risks and seizing the opportunities presented by the forces of globalisation, technological disruption and demographic trends.

He identified six key innovation challenges Australia must address in order to become a top-tier innovation nation.


Bill Ferris

1 Encouraging more Australian firms to achieve global best practice in innovative activity.

2 Getting greater economic and social benefits via more innovative procurement and service delivery performance of governments.

3 Developing an education system better able to meet the lifelong and changing needs of citizens and businesses.

4 Strengthening collaboration among our research and commercial sectors to increase innovation and commercialisation.

5 Maximising strategic international engagements to bring in the talent, knowledge and capital to fuel the innovation system.

6 Selecting high-impact projects capable of realising step-changes in Australia's innovation outcomes to 2030 and beyond.

Mr Ferris said meeting these challenges would be the best possible preparation for the technological disruption of traditional industries, an ageing population, climate change and environmental degradation, while ensuring we build on our competitive strengths.

$34.5 MILLION FOR NEW CRC PROJECTS

The Australian Government will invest $34.5 million in 17 projects involving cooperation between industry and research institutions on new technological solutions ranging from new biodegradable industrial lubricants to treating sleep apnoea. Funding under the Cooperative Research Centre Projects (CRC-P) initiative supports short-term, industry-led collaborations to solve industry problems and deliver tangible outcomes. The 17 second-round projects were selected from 57 applications and – with $79.9 million in cash and in-kind inputs from more than 70 participating businesses, partnerships and research institutions – represents a national investment of some $114 million in outcomes-focused research.

Among the 17 projects funded is research into:

- developing cost-effective, self-sustaining glasshouses that regulate light to maximise crop yield, and produce and store electricity for heating, cooling and irrigation;
- improving sleep apnoea therapies using treatments and devices tailored to individuals; and
- creating a manufacturing capability for a low-cost, point-of-care biosensor diagnostic device for early cancer detection as well as clinical trials and other pre-market work.

Industry, Innovation and Science Minister Senator Arthur Sinodinos AO announced the new projects and advised that founding outcomes for round-three CRC-P applications, which closed on 22 March, would be announced mid-year.

NEWS

LIQUID METALS KEY TO ELECTRONICS ADVANCE

An international team of researchers have developed a new technique using liquid metals to create integrated circuits that are just atoms thick – and could lead to the next big advance for electronics.

The process, using the low-melting-point metals gallium and indium, opens the way for the production of large electronic chip wafers around 1.5 nanometres in depth, compared with a 100,000 nm-thick sheet of paper.

Professor Kourosh Kalantar-zadeh, from RMIT University's School of Engineering, led the project, which also included colleagues from RMIT and researchers from CSIRO, Monash University, North Carolina State University and the University of California.

He said the electronics industry had hit a barrier and the discovery would allow for the next revolution in electronics.

"The fundamental technology of car engines has not progressed since 1920 and now the same is happening to electronics. Mobile phones and computers are no more powerful than five years ago.

"That is why this new 2D printing technique is so important – creating many layers of incredibly thin electronic chips on the same surface dramatically increases processing power and reduces costs.

A paper outlining the new technique, *Wafer Scale Two Dimensional Semiconductors from Printed Oxide Skin of Liquid Metals*, has been published in the journal *Nature Communications*.

DEFENCE LICENSES IMAGING TECHNOLOGY

A breakthrough system for imaging stress in aircraft structures has been licensed to Victorian company LRM Technologies.

The system uses small, low-cost infrared cameras to capture high-resolution, close-up images of structural stress at critical hot spots. High-performance aircraft are exposed to severe stresses, which need to be understood and controlled to reduce high ongoing maintenance costs and avoid catastrophic failure.

The licence agreement was signed by the Chief Defence Scientist Dr Alex Zelinsky FTSE and LRM Technologies Chairman Mr Ivan Cooper at the Australian International Air Show.

"This system is a significant advance in the stress measurement and diagnosis of airframe performance," Defence Industry Minister Christopher Pyne said.

Dr Zelinsky also signed a collaboration agreement at Avalon with Grollo Aerospace, to provide Defence with an enhanced capability for evaluating Australia's air defence systems.

Minister Pyne said this collaboration would give Defence a cost-effective means to test the performance of modern weapon systems targeted at Australian Defence Force aircraft.

"This partnership will improve the performance of Grollo's autonomous supersonic aerial target, Evader, which replicates the flight characteristics of advanced airborne threats," he said.

"The key objective is to enhance this autonomous air vehicle technology and maximise its utility for Defence applications."

The wet spinning line at Waurn Ponds.

Australian debut for carbon fibre

Australia now has the capacity to produce carbon fibre from scratch and at scale, with the opening of a wet spinning line – the 'missing link' in Australia's carbon fibre capability – at Waurn Ponds just outside Geelong.

The wet spinning line machinery takes a sticky mix of precursor chemicals and turns it into 500 individual strands of fibre, each thinner than a human hair. These are wound onto a spool to create a tape and taken next door to the massive carbonisation ovens to create the finished carbon fibre.

The CSIRO/ Deakin wet spinning line was custom built by an Italian company, with input from the organisations' own researchers.

The Italian company liked the design so much it made another for its own factory and the CSIRO/ Deakin machine has been described as "the Ferrari of wet spinning lines".

Carbon fibre combines high rigidity, tensile strength and chemical resistance with low weight and is used in aerospace, civil engineering, the military and cars, as well as in competitive sports.

Only a handful of companies around the world can create carbon fibre, each using their own secret recipe. To join this elite club CSIRO and Deakin researchers had to crack the code.

In doing so, using patented CSIRO technology, they've created what could be the next generation of carbon fibre that is stronger and of a higher quality.

The Director of CSIRO Future Industries, Dr Anita Hill FTSE, said the development was an important milestone.

"This facility means Australia can carry out research across the whole carbon fibre value chain: from molecules, to polymers, to fibre, to finished composite parts," Dr Hill said. "Together with Deakin, we've created something that could disrupt the entire carbon fibre manufacturing industry."

NEWS

Monash hosts biggest 3D metal printer

Xinhua Wu with the original printed jet engine.

Monash University's 3D printing initiative, headed by Professor Xinhua Wu FTSE, hosts the world's largest 3D metal printer, which was on display in March at the Melbourne International Airshow.

Monash has used it to print a large door hinge from a Chinese jet airliner. The aluminium hinge weighs 11 kilograms and is 40 by 80 by 39 centimetres in size. It is the largest powder bed 3D printed metal aerospace component printed to date.

The $3.5 million Xline 2000R printer acquired by Monash University is one of five made by German manufacturer Concept Laser. It is the only one outside America and Europe, the only one based in a university and the only one in the southern hemisphere available for contract manufacturing.

"The new printer allows us to make large complex shapes and unique tools quicker, lighter and with less waste," Professor Wu says.

There are several types of 3D printing. The powder bed approach uses a laser moving across a base plate to fuse fine coatings of metal powder, one layer at a time, to gradually build an object.

Monash University and spin-off company Amaero Engineering demonstrated their mastery of additive manufacturing in metal at the 2015 Airshow when they presented the world's first printed jet engine (*Focus* 189, page 33). Since then, Amaero has operated as the commercial arm of the 3D printing initiative.

"This new printer creates promising opportunities for advanced manufacturing in Australia for global markets," says Amaero CEO Barrie Finnin.

"Last year, we printed production components that are now flying in passenger jets and small turbojet engines. Our technology is also now operating in our manufacturing facility in Toulouse with our partner Safran – the French-based global aerospace and defence company."

"Now we can literally go bigger. This new capability will be of great interest to our aerospace and automotive customers in Europe, North America, Asia and Australia," Mr Finnin says.

The Amaero team presented a range of printed components for inspection at the Airshow, including:

- the first 3D printed jet engine (a Safran gas turbine power unit from a Falcon executive jet);
- the large jetliner door hinge;
- a large, complex air intake component; and
- a cut-away view of a new rocket motor design.

WE'RE WORKING WITH NEW ZEALAND AND ISRAEL

Australia and New Zealand will work together to tackle chronic disease, advance general health care and improve the accuracy and availability of GPS signals as part of a joint commitment to increase collaboration on research and innovation.

And the Australian and Israeli Governments have signed an agreement on bilateral cooperation in technological innovation, research, and development that will allow Australian companies to take advantage of opportunities in Israel's biotechnology, IT and R&D sectors.

Australia and New Zealand signed a Science, Research and Innovation Cooperation Agreement at the Australia New Zealand Leaders' Meeting in Queenstown, New Zealand, the first treaty of its kind between the two countries.

Industry, Innovation and Science Minister Senator Arthur Sinodinos AO said it formalised what has been a naturally close and enduring partnership and recognised the immense economic and social potential of merged efforts and resources.

Senator Sinodinos said the Israeli agreement was also "great news" as Australia sought to emulate the success Israel has experienced in commercialising research findings – drawing attention to ATSE's statements on the nation's tardiness in converting innovation into jobs and income.

"This agreement will help us learn from Israel's success at translating publicly funded research into commercial outcomes," he said.

The federal government previously chose Tel Aviv to host one of its five start-up 'landing pads' aimed at assisting entrepreneurs to commercialise their products and services through access to the expertise, infrastructure, innovation and marketing networks of local partners.

The other landing pads in the $11 million landing pad initiative, part of the $36 million Global Innovation Strategy to improve Australia's international innovation and science collaboration, are in Silicon Valley, California, Shanghai, Berlin and Singapore.

NEWS

Boosting plant biosecurity.

RDCs bond to boost plant biosecurity

Australia's seven plant Research and Development Corporations (RDCs) have announced a new partnership to protect and enhance timber, food and fibre production.

The group comprises Wine Australia, Forest Wood Products Australia, the Cotton RDC, the Grains RDC, the Rural Industries RDC, Sugar Research Australia and Horticulture Innovation Australia.

Headed by Horticulture Innovation Australia – a not-for-profit, grower-owned RDC for Australia's $9 billion horticulture industry – the new partnership approach will increase research coordination, reduce duplication and fill gaps in plant biosecurity R&D.

The initiative aims to create better linkages between industry research and the national biosecurity systems managed by the Australian and state and territory governments.

Horticulture Innovation Australia chief executive John Lloyd said this initiative has never been more vital for Australian producers.

"To date, Australia's approach to managing research investment and delivery for our plant industries has been fragmented and lacking coordination. This is simply because the biosecurity space is incredibly complicated, crossing more than 50 commodities, all states and territories, and countless stakeholder groups," he said.

"The role of the Rural RDCs is to prioritise, invest in, manage and evaluate research and other activities that deliver impacts for producers and the broader community. We have the skills, people and systems to effectively deliver the research management we need for better biosecurity.

"What has been missing for plant biosecurity is the link between the research effort and the biosecurity community. Building this connection will increase our capacity to make sure our research investments are targeting national research priorities."

SOLAR GREENHOUSES MAY MAKE DESERTS BLOOM

Greenhouses powered by nanotechnology developed in WA could turn the driest deserts into productive agricultural land.

A $1.6 million Federal grant will be used to build a 300 m^2 greenhouse using transparent glass that can generate 50 watts of power per square metre of surface area.

The 'solar' glass also allows 70 per cent of visible light to pass through while blocking 90 per cent of solar UV and infrared radiation.

The solar glass, developed by Edith Cowan University's Electron Science Research Institute (ESRI) in collaboration with glass power and insulation specialists ClearVue Technologies, will provide enough power to run heating or cooling for the greenhouse, as well as desalination to provide water.

ESRI Director Professor Kamal Alameh said the solar glass could be tailored to produce the perfect growing conditions for particular plants.

"Being able to selectively control light radiation, thus maximising the crop yield, while producing and storing electricity for water desalination, irrigation, heating and air conditioning, will enable greenhouses to operate in a closed environment," he said.

"This is particularly significant for parts of the world that are too hot and dry for traditional greenhouse agriculture."

The solar greenhouse concept.

SOUTH WEST AGRICULTURE CONFERENCE PLANNED

WA's South West Science Council (SWSC), chaired by former WA Division Chair Professor Adrian Egan FTSE, and the Ag Institute of Australia (AIA) are holding a joint conference on 18 and 19 May.

It aims to showcase the region's agricultural industries and the regional brand, and to identify:

- actions to increase farm business productivity and profitability, and reliability of quality and supply, including use of precision management tools that support timely decision-making and tactical adjustment;
- improvements in the management of risk and uncertainty in the face of challenges such as climate change and increasing competition for land and water; and
- increased agility responding to short-term changes in operational and trading environments.

The conference will include presentations from local specialists and leading scientists in technical innovation in agriculture and feature talks by recent agricultural graduates from around Australia who are competing for a national student award.

NEWS

Wheat yields in decline.

Australia's stalled wheat yields

Australia's average wheat yields, which more than tripled between 1900 and 1990 due to technological advances, did not increase in the subsequent 15 years, according to CSIRO researchers.

They have found that Australia's yield potential (determined by the climate and soil type, managed using best practice and current technology) declined by 27 per cent over the past 25 years.

The findings indicate a risk to the future prosperity of Australia's more than $5 billion per annum wheat industry, which contributes around 12 per cent of the total wheat traded globally.

CSIRO team leader Dr Zvi Hochman said the study found that Australia's wheat-growing zone had experienced an average rainfall decline of 2.8mm or 28 per cent per cropping season, and a maximum daily temperature increase of around 1° from 1990 to 2015.

He said that despite the adverse trend in growing conditions, farmers have so far managed to maintain yields at 1990 levels, around 1.74 tonnes per hectare.

The study analysed 50 weather stations with the most complete records across Australia's wheat growing regions, spanning five states from the east to the west coast.

"Assuming the climate trends we have observed over the past 26 years continue at the same rate, even if farmers continue to improve their practices, it is likely that the national wheat yield will fall," Dr Hochman said.

"We estimate that the recent average yield of 1.74 t/ha will fall to 1.55 t/ha by 2041."

DEGRADED LANDSCAPES SLOW BEES DOWN

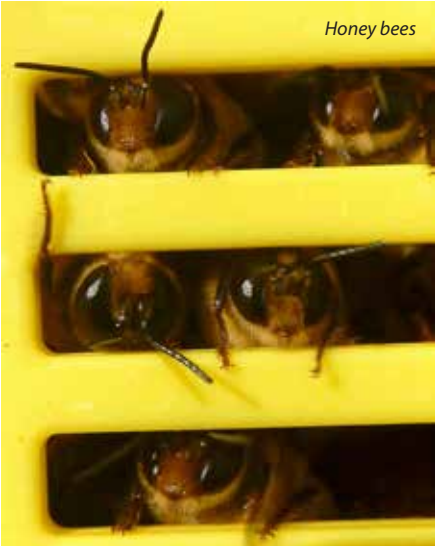
A new study into honey bees has revealed the significant effect human impacts on the environment have on a bee's metabolism and, ultimately, its survival.

Researchers from The University of Western Australia, in collaboration with Kings Park and Botanic Garden, Curtin University and CSIRO, have completed a world-first study on insect metabolism in free-flying insects, focusing on the honey bee. Bees are crucial for the planet, pollinating one-third of everything we eat.

Landscapes that have been degraded have a reduction in resources, which affects the metabolic rate of the honey bee and puts more strain on its body's ability to function.

Emeritus Professor Don Bradshaw from UWA's School of Biological Sciences said the researchers wanted to find out how honey bees' metabolism was impacted by human-made changes to the environment such as clearing of land.

Research showed that the metabolic rate of bees in natural woodland was significantly higher than in a degraded environment, where the bees foraged less and depended on stored resources inside the hive, Professor Bradshaw said.



Honey bees

The research has important implications for understanding environmental impacts on bees and may offer insight into the way other insects' metabolism works and how it affects their behaviour.

SOIL LINKS TO ANTIBIOTIC-RESISTANT BACTERIA

Researchers from Edith Cowan University's School of Science and School of Medical and Health Sciences have found that soils containing even small amounts of lead, manganese or aluminium contain bacteria with antibiotic resistance.

Researcher Dr Annette Koenders said previous studies carried out overseas had shown a link between high levels of metal contamination in soil and antibiotic-resistant bacteria.

"But our study, undertaken in Western Australia, shows that even low concentrations of metals are correlated with increased antibiotic resistance in bacteria," Dr Koenders said.

"This antibiotic resistance in bacteria occurs as part of a naturally occurring response to protect from pollutants or stress, especially toxic metals."

Dr Koenders said the results showed that an assessment of the metals present in soil should form part of environmental approvals for new developments.

ATSE PEOPLE

Eleven Fellows honoured on Australia Day

The Academy congratulates the 11 Academy Fellows who received Australia Day honours.

ATSE Fellow and Academy of Science President Professor Andrew Holmes AC FAA FTSE was named a Companion of the Order of Australia.

Former ATSE President Professor Peter Gray was among seven Fellows named Officers of the Order of Australia – along with Dr Graeme Blackman, Professor Max Lu, Professor Colin Masters, Dr Chris Roberts, Mr David Thodey and Professor Gordon Wallace.

Dr Vaughan Beck and Professor John Yeaman ware named Members of the Order of Australia and Professor German Spangenberg was awarded the Public Service Medal.

AUSTRALIA DAY HONOURS 2017

Professor Andrew Holmes AC FRS FAA FTSE, Emeritus Professor of Chemistry, University of Melbourne, and President of the Academy of Science, was named a Companion of the Order of Australia for eminent service to science through developments in the field of organic and polymer chemistry as a researcher, editor and academic, and through the governance of nationally recognised, leading scientific organisations.

Dr Graeme Blackman AO FTSE, Chair of the National Stem Cell Foundation, was named an Officer of the Order of Australia for distinguished service to the pharmaceutical industry, to scientific research and policy development, to theological education and the Anglican Church of Australia, and to aged care.

Professor Peter Gray AO FTSE, Founding Director, Australian Institute for Bioengineering and Nanotechnology, was named an Officer of the Order of Australia for distinguished service to science in the field of bio-engineering and nanotechnology as an academic and researcher, and to professional biotechnology associations.

Professor Max Lu AO FAA FTSE, President and Vice-Chancellor, University of Surrey, was named an Officer of the Order of Australia for distinguished service to education, to national and international research in the fields of materials chemistry and nanotechnology, to engineering and to Australia–China relations.

Professor Colin Masters AO FAA FTSE, Head, Neurodegeneration Division, The Florey Institute, and Executive Director, Mental Health Research Institute, was named an Officer of the Order of Australia for distinguished service to medical research through international and national contributions to understanding Alzheimer's and other neurodegenerative diseases.

Andrew Holmes

German Spangenberg

Graeme Blackman

Dr Christopher Roberts AO FTSE, former Chief Executive Officer, Cochlear, was named an Officer of the Order of Australia for distinguished service to science and the development and commercialisation of medical biotechnology, particularly through the cochlear implant program, and the management of respiratory conditions.

Mr David Thodey AO FTSE, Former Telstra CEO and now Chair of CSIRO, was named an Officer of the Order of Australia for distinguished service to business, notably to the telecommunications and information technology sectors, to the promotion of ethical leadership and workplace diversity, and to basketball.

Professor Gordon Wallace AO FTSE, Executive Research Director, ARC Centre of Excellence in Electromaterials Science, University of Wollongong, was named an Officer of the Order of Australia for distinguished service to science and research in polymer materials and their use in biomedical applications, and to national and international collaboration with industry.

Dr Vaughan Beck AM FTSE, ATSE Senior Technical Advisor, was named a Member of the Order of Australia for significant service to engineering, to tertiary education administration and research, and to professional academies.

Professor John Yeaman AM FTSE, Professor, Civil Engineering and Construction, University of the Sunshine Coast, was named a Member of the Order of Australia for significant service to civil engineering and road asset maintenance management, to professional organisations, and to the community.

Professor German Spangenberg PSM FTSE, from AgriBio, the Victorian Centre for AgriBioscience, was awarded the Public Service Medal for outstanding public service through scientific research programs in the agricultural sector in Victoria.

Former Fellow Dr Greg Constable AO, a leading cotton scientist and 2006 Clunies Ross Medal winner, was honoured for distinguished service to agricultural science as an agronomist and plant breeder, particularly to cotton management and production, and to professional national and international scientific organisations.

Chris Roberts

Vaughan Beck

Peter Gray

ATSE PEOPLE

Veena Sahajwalla

Veena Sahajwalla wins Indian honour

Professor Veena Sahajwalla FTSE, UNSW's internationally renowned waste innovator, is the first woman to be awarded the prestigious Jubilee Chair and Professorship by the Indian Academy of Sciences.

ARC Laureate Professor Sahajwalla and her team at the UNSW Centre for Sustainable Materials Research and Technology (SMaRT) are revolutionising recycling science to deliver practical and commercially viable solutions for many complex wastes otherwise destined for landfill.

The Jubilee Chair is open to any scientist from any discipline worldwide and has most recently been held by leading academics from Harvard University and the University of Cambridge.

The breakthrough science developed by Professor Sahajwalla and her team enables 'green materials' and products to be manufactured entirely, or largely, from the rubbish the world throws away, cleaning up waste stockpiles and reducing pressure on landfills and finite natural resources.

"Green materials are cheaper, they reduce energy usage and emissions, they are non-toxic and they can be recycled at the end of their lives – and they look just as good and perform just as well as materials made of virgin raw materials," Professor Sahajwalla said.

These include building products made from waste and a whole range of new innovative resources for the production of advanced materials, such as carbon nanoparticles and metallic alloy and non-metallic particles.

The waste streams being transformed at UNSW are among the world's most challenging, including toxic electronic waste (e-waste) and the complex mixed waste left behind after a vehicle is scrapped and stripped of its useful metal.

"The Jubilee Chair and Professorship is a really great honour. These kinds of waste solutions are critical for building new, clean industries of the future," said Professor Sahajwalla, who was born in Mumbai and studied in India before embarking on her international research career.

"India urgently needs a safe, low-cost recycling solution for e-waste. Our approach is to enable every local community to transform their waste into valuable metal alloys, instead of sending their old devices to landfill."

Professor Sahajwalla also heads the UNSW-based ARC Green Manufacturing Hub that brings together researchers and industries to deliver new solutions to wastes ranging from tyres, laminated glass and plastics to industrial and agricultural waste.

In 2016, Professor Sahajwalla was named one of Australia's most innovative engineers by Engineers Australia, the latest in a long list of Australian and international honours.

She is best known as the inventor of 'green steel', a patented, commercialised steelmaking process that is transforming waste tyres in the production of steel in Australia and internationally.

"Veena is an internationally recognised research leader and trailblazer," said UNSW Deputy Vice-Chancellor Research Nicholas Fisk.

"She is a wonderful model for our students, particularly young women considering engineering or science as a career."

VANESSA GUTHRIE ON ABC BOARD

Dr Vanessa Guthrie FTSE has been appointed a non-executive director of the Australian Broadcasting Corporation (ABC) Board for a period of five years.

Dr Guthrie has substantial experience from a broad range of executive roles, primarily in the mining and energy industries. She was previously CEO of Toro Energy.

She is the Chair and a director of the Minerals Council of Australia, Deputy Chair of the Western Australia Cricket Association and an independent director of the Murlpirrmurra Connection.

She is joined as a non-executive director by Ms Georgina Somerset, an experienced rural leader and regional strategist from Queensland who runs a family beef cattle farming business.

Vanessa Guthrie

ATSE PEOPLE

John Connell shaped engineering practice

When Dr John Connell AM FTSE, celebrated his 100th birthday in 2013 the founder of Connell Wagner, now Aurecon, was renowned as one of the most influential engineers of his generation.

His centenary was marked by an Engineers Australia function in Melbourne attended by a number of his former colleagues and clients.

President of Engineers Australia's Victoria Division, Mr John McIntosh, said: "The man we honour today is a leader who held an extraordinary vision into the future and the very rare capacity to bring that future to pass. Your leadership is unrivalled and your legacy, a challenge for those of us who would walk in your footsteps."

Engineers Australia said Dr Connell's vision shaped much of our built environment, creating some of Australia's most iconic structures and his legacy would be that of a great humanitarian, whose vision and leadership helped shape the landscape of Australia.

Aurecon also hosted a birthday event and in an interview Dr Connell talked about

John Connell

his involvement in projects such as the Melbourne Underground Rail Loop, where he pioneered the delivery of multidisciplinary services, and partnering with international consultancies in joint venture.

"John took a world view at a time when many consulting practices were focusing on local issues and locally based solutions," Aurecon CEO Paul Hardy said.

Dr Connell, who died in Melbourne on 26 May 2016, aged 102, helped shape the cities and infrastructure of Australia in the post-WWII period and has left a legacy that endures today.

During his long career he was Director of the Gas and Fuel Corporation Victoria and Overseas Projects Corporation Victoria; Vice-President and later board member of the Austin Hospital; President of the Freemasons Hospital (1986–88); Member of Faculty of Engineering, University of Melbourne; Scientific Associate of the Zoological Board of Victoria; Life Governor of Ivanhoe Grammar School; and Elder of the Presbyterian Church.

Dr Connell was educated at Royal Melbourne Institute of Technology (Hon DEng) and at the British Institute of Technology (CEng), and won the 1980 Kernot Medal from the University of Melbourne.

A Fellow since 1985, he was nominated by engineering luminaries the late Sir John Holland AC FTSE and the late Professor Peter Joubert AM FTSE and supported by Academy stalwarts the late Professor Howard Worner CBE FTSE and Professor Len Stevens AM FTSE.

His nomination noted his distinguished record as an engineer and manager.

"He played a pioneering and innovative role in the utilisation of reinforced concrete in multi-storeyed buildings, roof pergolas and cantilevered concrete canopies", his nomination said, noting his contributions to "conceptual design, general and detailed engineering in in many major building projects in Australia".

DAVID BOGER NAMED A US NAE MEMBER

Professor David Boger FRS FAA FTSE, from the Department of Chemical Engineering at Monash University, has been named a Member of the US National Academy of Engineering (NAE) – one of 84 new members.

Professor Boger, a Fellow since 1989, was honoured "for discoveries and fundamental research on elastic and particulate fluids and their application to waste minimisation in the minerals industry".

The 2017 election of 84 new members and 22 foreign members brings the total US membership to 2281 and the number of foreign members to 249.

NAE membership honors those who have made outstanding contributions to "engineering research, practice, or education, including, where appropriate, significant contributions to the engineering literature" and to "the pioneering of new and developing fields of technology, making major advancements in traditional fields of engineering, or developing/ implementing innovative approaches to engineering education".

Newly elected members will be formally inducted during a

David Boger

ceremony at the NAE's annual meeting in Washington in October.

Professor Boger's contributions to fundamental research in fluid mechanics are highlighted by a class of fluids which now bear his name globally – Boger Fluids.

These fluids are constant-viscosity elastic (non-Newtonian) fluids that behave as both liquids and solids.

The detailed experimental investigations using such materials to define fluid elasticity effects in important flows, the linking of basic surface chemistry to the continuum properties and processing of particulate fluids and the development of novel methods for flow property measurement have resulted in significant industrial outcomes in the petroleum, food, polymer and minerals industries.

For a lifetime of pioneering work in fluid mechanics, at both Monash and the University of Melbourne, Professor Boger received the 2005 Prime Minister's Prize for Science.

ATSE PEOPLE

Min Gu at heart of new nano optical lab

RMIT says its new Laboratory of Artificial Intelligence Nanophotonics, developed to support its Director, Professor Min Gu FAA FTSE, will enable the university to play a leading role in national and international brain research.

Frank McGuire congratulates Min Gu at the opening.

The laboratory is being equipped with world-class laser facilities and aims to become the world's first photonics group in artificial-intelligence-driven optical devices at nanoscale. It will allow researchers to investigate artificial neural networks at the same length scale as those in nature.

It was opened by RMIT Vice-Chancellor and President, Professor Martin Bean CBE, with the Victorian Parliamentary Secretary for Medical Research, Frank McGuire, in attendance.

Professor Bean said the new laboratory would allow RMIT researchers to contribute to international research, such as the European Commission's Human Brain Project, Japan's Brain/MINDS Project, the US BRAIN Initiative and the China Brain Project.

Professor Bean said the laboratory had been developed to support Professor Gu, Associate Deputy Vice-Chancellor for Research Innovation and Entrepreneurship, who joined RMIT last year – and was named the 2016 Victoria Prize winner for Science and Innovation.

"This is exciting because it opens the way to develop the science and technology involved in the 3D nano-printing of artificial 'minds', which will impact significantly on mental health and care.

"Mental illness is increasingly being recognised as a pressing public health issue.

"In Australia, we spend $8 billion a year on mental health services and the human toll is, of course, incalculable.

"Better understanding of the human brain can help to diagnose and cure mental disorders."

WAINWRIGHT CHAIRS NSW ENTREPRENEURSHIP SCHOOL

Former University of New South Wales Vice-Chancellor, Emeritus Professor Mark Wainwright AM FTSE, has been named chairman of the Sydney School of Entrepreneurship (SSE), a collaboration involving TAFE NSW and the 11 NSW-based public universities.

SSE was launched with a $25 million cornerstone investment by the NSW Government in 2016.

Operations have commenced and will include activities across rural, regional and metropolitan NSW.

Launch of the headquarters campus at Ultimo, in Sydney, is planned for semester two 2017.

NSW Skills Minister John Barilaro said the school would ultimately offer training, support, mentoring and co-curricular activities to up to 1000 would-be entrepreneurs from diverse disciplines and backgrounds.

"The board brings together remarkable expertise in education, startups, innovation and small business to help create an innovation powerhouse for NSW," Mr Barilaro said.

Also on the board are:

- University of Technology Sydney Vice-Chancellor Professor Attila Brungs;
- Western Sydney University Deputy Vice-Chancellor Professor Denise Kirkpatrick;
- University of Newcastle Deputy Vice-Chancellor Professor Kevin Hall;
- electrical engineer Dr Raji Ambikairajah;
- engineer and venture capitalist Ms Fiona Pak-Poy; and
- public relations proprietor Ms Liane Sayer-Roberts.

The school is run by business educator Mr Nick Kaye, former head of the Stockholm School of Entrepreneurship, which has been credited with spawning two 'unicorns' – start-ups valued at more than US$1 billion.

Professor Wainwright's other appointments include: Chair, Smart Services Co-operative Research Centre Board; Chair, Intersect Australia Pty Ltd Board; Chair, TAFE NSW Higher Education Governing Council; Director, AARNet Pty Ltd; Chair, Cancer Institute NSW Grants Program; Member Hong Kong PolyU International Advisory Board; and Member Singapore Management University International Academic Review Panel.

Mark Wainwright

ATSE PEOPLE

David Strangway was a distinguished Canadian

Professor David Strangway OC FTSE was one of the dominant influences on research and innovation in Canada during a life-long academic and public service career.

He was a geophysicist and university administrator and the founder, first President and first Chancellor of Quest University Canada, a private non-profit liberal arts and sciences university in Squamish, British Columbia, which opened in September 2007. He was also President Emeritus of the University of Toronto and the University of British Columbia.

A Foreign Fellow since 2003, Professor Strangway died in Canada on 13 December 2016, aged 82.

Born in Ontario, he began his teaching career as an Assistant Professor of Geology at the University of Colorado (1961–64). In 1965 he joined Massachusetts Institute of Technology for three years as both an Assistant Professor of Geophysics and Researcher. In 1970 he joined NASA as the Chief of the Geophysics Branch and was responsible for the geophysical aspects of the Apollo missions.

In 1972 he was awarded the NASA Exceptional Scientific Achievement Medal. He designed lunar experiments for Apollo astronauts and also was involved in the examination of returned moon rocks that contributed to knowledge of the solar system.

He was a Vice-President of the University of Toronto and the chairman of its Geology Department (1973–83) and later the university's 11th President. He was the 10th President of the University of British Columbia (1985–97).

From 1998 to 2004, he was the President and Chief Executive Officer of the Canada Foundation for Innovation (CFI), an independent Government corporation formed to fund research infrastructure. CFI was founded in 1997 to fund and revitalise national research infrastructure programs that would enable Canadian universities, colleges and research hospitals to carry out across-the-board scientific and technological projects of benefit to all Canadians.

It was during this time that he played a key role in helping the Canadian Government create the Canada Research Chairs. This program, funded at the level of CA$300 million a year, has created 2000 new positions in Canadian universities.

Professor Strangway retired from CFI to devote his full attention to Quest University Canada during the construction and start-up phases of its development.

He served on many provincial and national bodies and in 1996 was made an Officer of the Order of Canada for being an "internationally respected as an outstanding scientist and senior academic administrator".

David Strangway

SUSAN POND HEADS AINST

Professor Susan Pond AM FTSE has been appointed Director of the Australian Institute for Nanoscale Science and Technology (AINST), at the University of Sydney. Her appointment is for 12 months, initially on a part-time basis.

Susan Pond

The university describes AINST – which incorporates the $150 million Sydney Nanoscience Hub – as its latest step in the creation of flexible, interdisciplinary institutes that are devoted to bringing the best people and infrastructure together in the support of frontier research.

The Institute, comprising several flagship initiatives, hosts some of the capabilities of the Australian National Fabrication Facility and of the Australian Microscopy and Microanalysis Research Facility – both co-funded by the National Collaborative Research Infrastructure Strategy (NCRIS).

Professor Pond is a senior leader in business and academia with a distinguished record in executive positions including appointments as Chair and Managing Director of Johnson & Johnson Research Pty Ltd.

She is an Adjunct Professor in Engineering and Information Technologies at the University of Sydney and Director of both Biotron Ltd and Vectus Biosystems Ltd.

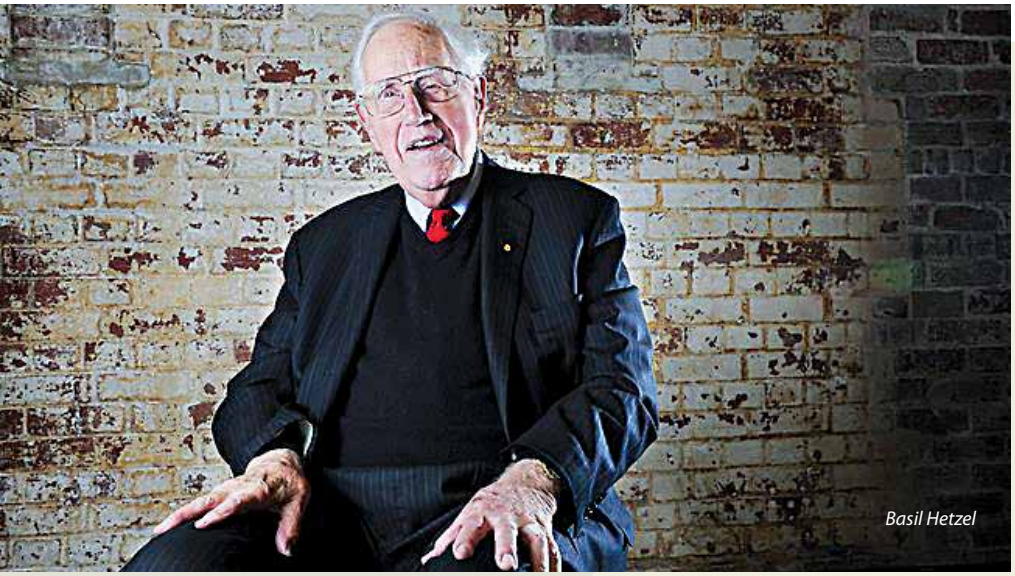
She is Chair of the Australian Institute of Bioengineering and Nanotechnology and has served on many significant Australian Government boards and committees, most recently on the Board of the Australian Nuclear Science and Technology Organisation (ANSTO).

Professor Pond has been consistently recognised for her significant national and international contributions in biotechnology and medicine. In 2013 she was named as one of the *Australian Financial Review* and Westpac's Top 100 Women of Influence. She is a former Director of ATSE and was chair of its Audit and Risk Committee.

Professor Pond's new role replaces the interim appointments of the three AINST initial directions – Professor Thomas Maschmeyer FAA FTSE, Professor Simon Ringer and Professor Zdenka Kuncic.

Professor Maschmeyer is Professor of Chemistry and Founding Director of AINST, Director of the Laboratory of Advanced Catalysis for Sustainability (School of Chemistry) and heads the Sydney Energy Storage Research Network.

ATSE PEOPLE



Basil Hetzel

Basil Hetzel a giant in medical research

Professor Basil Hetzel AC FTSE was renowned for his pioneering medical research on iodine deficiency and thyroid disease.

He became an international advocate for iodine supplementation, which aided the creation of the International Council for Control of Iodine Deficiency Disorders (ICCIDD). Its work using iodine supplements to prevent thyroid disease is credited with saving 80 million lives.

Between 1992 and 2000 Professor Hetzel was Lieutenant Governor of South Australia and from 1992 to 1998 he served as the Chancellor of the University of SA.

He died on 4 February in Adelaide, aged 94.

He was born in London while his anaesthetist father was working there, returned to Adelaide where he attended school and studied medicine at the University of Adelaide.

He was a Fulbright Research Scholar in the 1950s, which included an appointment at New York Hospital, and in 1954 he undertook a Research Fellowship in the Department of Endocrinology and Metabolism at St Thomas' Hospital, London.

His first job after completing medical studies was as a Resident Medical Officer at Adelaide's Parkside Mental Hospital (1946–47. Upon completion of his Fulbright Scholar commitments, Professor Hetzel was appointed as the first Michell Research Scholar at the University of Adelaide, then became a Reader in Medicine at the Queen Elizabeth Hospital in Adelaide before moving to Monash University as the Foundation Professor of Social and Preventive Medicine.

In 1956 Professor Hetzel became a founding member of the SA Mental Health Association and assisted with the establishment of Lifeline, the national crisis support service. He also held the position of first chief of the CSIRO Division of Human Nutrition.

In 2001 the Queen Elizabeth Hospital established the Basil Hetzel Institute for Medical Research in his honour and, in 2005, the building for health sciences at the University of SA's City East campus was named the Basil Hetzel building; the campus library also has a Hetzel room, which contains a collection of his research.

A Fellow since 1981, Professor Hetzel worked in remote areas of Papua New Guinea with the Public Health Department of the then Territory, and his research concluded that the endemic goitre and associated cretinism was attributable to an iodine-deficient diet. He demonstrated that dietary supplementation would entirely prevent these illnesses. He also led research in PNG that identified the link between iodine deficiency and significant brain damage in unborn children.

In the 1980s, supported by the Australian Agency for International Development, he became an international advocate for iodine supplementation. This was part of the stimulus for the creation of the International Council for Control of Iodine Deficiency Disorders (ICCIDD).

As a result of its advocacy, many countries have now legislated that salt for human and animal consumption must be iodised.

In 2010 the ICCIDD established a Basil Hetzel International Award for Communications for individuals who contribute to promoting awareness of iodine nutrition.

His son, Dr Jay Hetzel FTSE, has been a Fellow since 2001.

BARNEY GLOVER BACKS EVIDENCE AND EXPERTS

Universities Australia Chair Professor Barney Glover FTSE has urged Australians to defend the role of evidence and experts, arguing they are more important than ever in a 'post-truth' world. In a speech to the National Press Club, Professor Glover described the growing emergence in our time of a "creeping cynicism – even outright hostility – towards evidence and expertise", noting how agendas are displacing analysis in much of our public debate.

Barney Glover

"And yet – as we strive to cure cancer, save lives from preventable disease, navigate disruption, lift living standards, overcome prejudice and prevent catastrophic climate change – expertise has never been more important," he said.

Professor Glover noted that standing up for specialist expertise did not discount the wisdom of the layperson. "And it doesn't mean universities have all the answers: far from it … [But] my plea is this: let's not deride experts, nor the value of expertise.

"Because in an era where extremists and polemicists seek to claim more and more of the public square, our need for unbiased, well-researched information has never been greater."

Universities and university expertise were invaluable as people sought to reclaim the role of facts in public debates.

Professor Glover also revealed the extent to which universities are powering Australia's startup economy. He launched a new report – *Startup Smarts: universities and the startup economy* – which states that more than 80 per cent of Australian startup founders are graduates.

"It confirms that universities and their graduates are the driving force in Australia's startup economy," he said.

ATSE PEOPLE

Minor planet named after Bernard Bowen

A minor planet in the solar system has been named Bernardbowen, in honour of long-term Western Australian Fellow Dr Bernard Bowen AM FTSE. The naming rights to the celestial body were won in a competition by the Australian citizen science project theSkyNet.

The minor planet was named by the International Centre for Radio Astronomy Research (ICRAR), of which Dr Bowen was founding chairman, on theSkyNet's proposal.

Bernardbowen sits in the asteroid belt between Mars and Jupiter and takes 3.26 Earth years to orbit the Sun. It was discovered in 1991 and until now has been known as (6196) 1991 UO4.

Bernardbown is one of 17 newly christened minor planets. Others include Kagura, after a traditional Shinto theatrical dance, and Mehdia, which is equivalent to the Arabic word for gift.

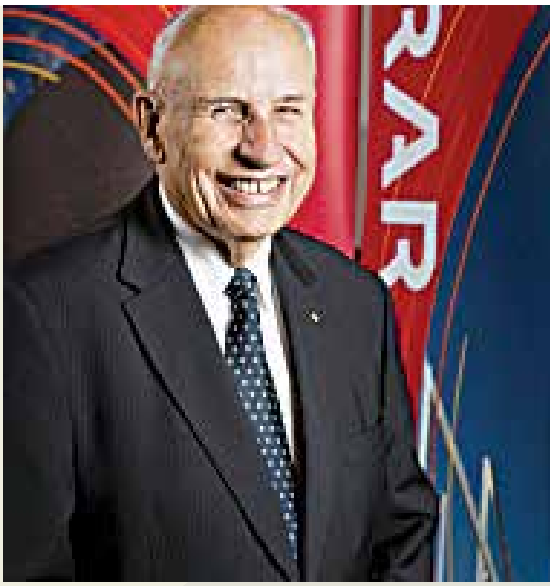
Dr Bowen (86), a Fellow since 1978, is renowned as one of the country's finest science administrators and has presided over scientific advances ranging from the oceans to the skies.

He is a former head of the WA Environmental Protection Authority, was instrumental in the establishment of ICRAR in 2009 and helped bring part of the Square Kilometre Array telescope to WA.

Earlier he was CEO of the WA Department of Fisheries and Chair of its Marine Sciences Institute.

Based at ICRAR, theSkyNet has been running since 2011 and sees citizen scientists donating their spare computing power to help Australian astronomers uncover the mysteries of the Universe. Its 50,000-odd volunteers entered an International Astronomical Union (IAU) contest to name planets beyond our Solar System.

ICRAR is a joint venture between Curtin University and The University of Western Australia, with support and funding from the WA Government.



Bernard Bowen

The IAU is the international astronomical organisation that brings together more than 10 000 professional astronomers from almost 100 countries. Its mission is to promote and safeguard the science of astronomy in all its aspects through international cooperation. The IAU also serves as the internationally recognised authority for assigning designations to celestial bodies and the surface features on them.

CANBERRA DINNER WITH ROBIN GRIMES

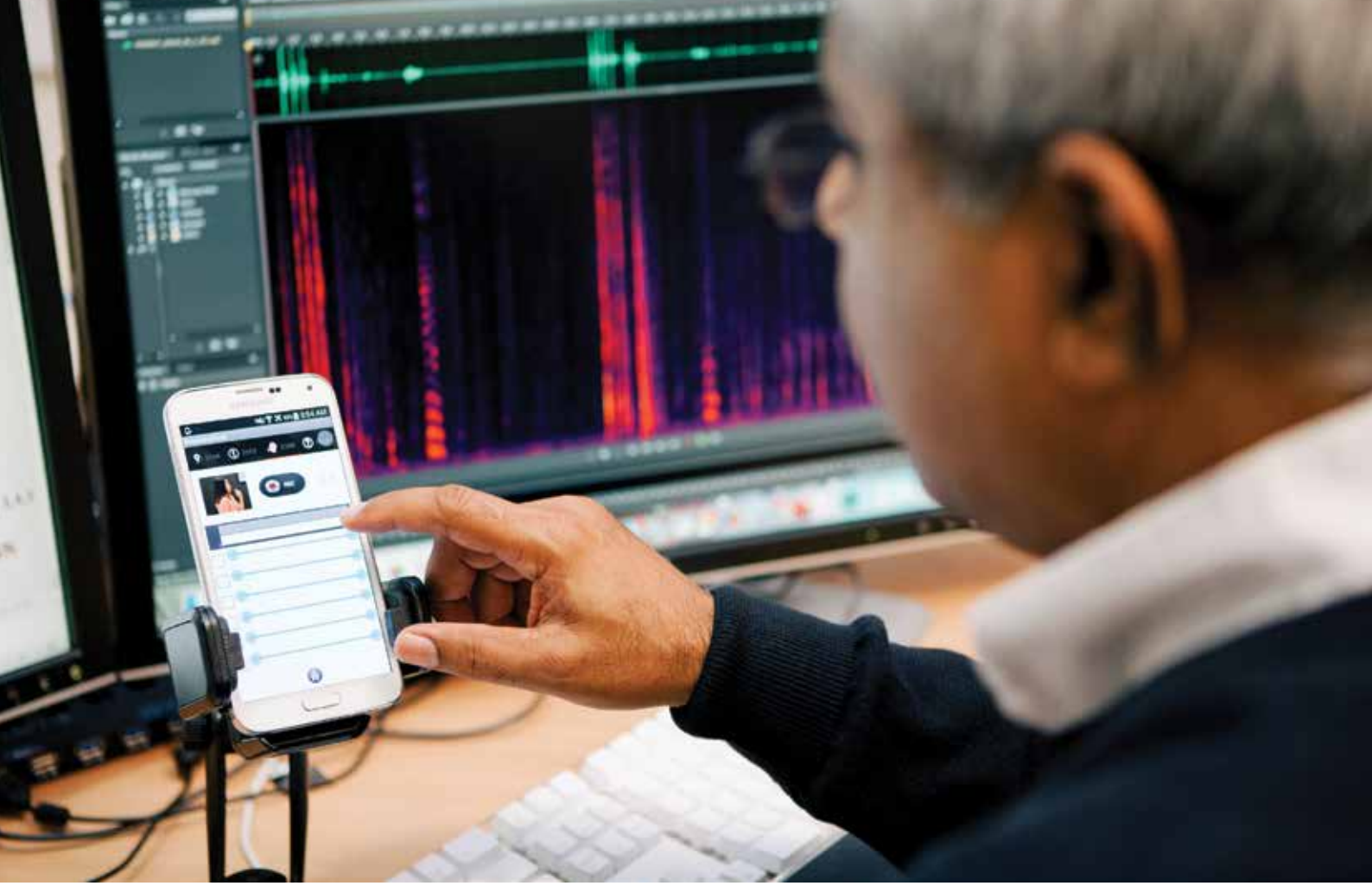
ATSE organised a private dinner in Canberra attended by key bureaucrats and Academy figures, including the President, Professor Hugh Bradlow FTSE, to mark the visit to Australia by Foreign Fellow Professor Robin Grimes FTSE, Chief Scientific Adviser at the Foreign and Commonwealth Office in London and Professor of Materials Physics at Imperial College.

Professor Grimes has advised the House of Lords Science and Technology Committee's inquiry into nuclear research requirements, and was part of the Scientific Advisory Group for Emergencies (SAGE) that provided official advice on the 2011 Fukushima disaster. He has considerable experience of high-level international work, including overseas missions to India, Vietnam, South Korea, Malaysia and Japan.

His research is focused on the use of high-performance computing techniques to understand the behaviour of materials for energy applications including nuclear fission and fusion, fuel cells, batteries and solar cells. He is also Principal Investigator of the Research Council's UK Nuclear Fission consortium project.

Other Fellows attending the dinner were Director Professor Kaye Basford FTSE, CEO Dr Margaret Hartley FTSE, ACT Division Chair Professor John Richards AM FTSE, UNSW Dean of Engineering Professor Mark Hoffman FTSE and Geoscience Australia CEO Dr Chris Pigram FTSE.

Hugh Bradlow presents Fellowship certificate to Robin Grimes in Canberra.



Coughing up the data for diagnosis

UQ researchers are working with hospitals, non-government organisations and industry to develop non-invasive technology for diagnosing illness, to boost mass health screening and minimise disease.

The sound of a cough seems like a simple thing, but it is one of the fundamental symptoms of a range of respiratory diseases and also one of the most underutilised methods of diagnosis amongst physicians.

Associate Professor Udantha Abeyratne and his team have developed diagnostic technology that can identify respiratory diseases based on mathematical analysis of a cough through a smart phone or other device.

During a cough, the lower airways, including the lungs, are directly connected to the atmosphere through a column of air that can support a high-bandwidth channel. The researchers call this channel the "information superhighway" and use the information transmitted within it to make real-time decisions about a person's health.

The research has culminated in a spin-off company, ResApp Health Ltd, that will save lives by offering an easy-to-use tool for earlier and more accurate diagnosis. With respiratory disease the third leading cause of death worldwide, the potential global health and economic impact of this technology is phenomenal.

Health technology is a key education and research area for UQ's School of Information Technology and Electrical Engineering, as evidenced by a number of established collaborative links with industry and other universities. For more information visit **itee.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.

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