

# FOCUS

## WOMEN IN THE DRIVING SEAT

A close-up photograph of a car's side-view mirror. The mirror reflects a woman with dark hair, wearing a black jacket, looking directly at the camera. The background in the reflection shows a residential building and some greenery.

WE NEED A CRITICAL MASS OF WOMEN  
IN AUSTRALIAN LEADERSHIP ROLES

# 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.

Key speakers presenting at the **Dialogue** will include:

- Professor Ian Frazer AC FRS FAA FTSE, Ambassador and Chair, Translational Research Institute
- Professor Elizabeth Gaelhoed, Health Economist, School of Population and Global Health, University of Western Australia
- Professor Ken Hillman AO, Professor of Intensive Care, University of New South Wales
- Professor Rajeny Thomas, Arthritis Queensland Chair of Rheumatology, University of Queensland
- Professor Rajesh Vasa, Deputy Director, Deakin Software and Technology Innovation Laboratory

For more information on the **Dialogue** program and issues paper see [www.atse.org.au/ageing](http://www.atse.org.au/ageing)

For information on sponsorship packages contact [sue.wickham@atse.org.au](mailto:sue.wickham@atse.org.au)

**Registrations open end of February.**

**Save the date**  
**14 June 2017, Brisbane**  
**[www.atse.org.au/ageing](http://www.atse.org.au/ageing)**

# Contents



**3** **What's happening with women in business?**  
By Rosalind Dubs and Michael Edwards

**7** **Driving change in our universities – starting with engineering**  
By Graham Schaffer, Else Shepherd, Doreen Thomas and Mark Hoffman

**11** **Changing the way we do things**  
By Kathryn Fagg

**13** Why aren't there more women running higher education?  
**16** SAGE is driving gender equality and social good  
**19** The Government is tackling gender inequality  
**21** Childhood clues to career esteem  
**24** Not whether, but how – and how quickly  
**25** Oration Dinner honours New Fellows  
**26** Newcastle engineer wins Batterham Medal  
**26** ATSE backs NRI Roadmap draft  
**27** Research engagement trial to start this year  
**28** Industry–research collaboration through a Defence prism  
**29** Education for innovation  
**48** ATSE People

Front cover photo: In the driving seat (Photo: iStock).



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*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:

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- Manufacturers and suppliers to the industry
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**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 ROSALIND DUBS AND MICHAEL EDWARDS  
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# What's happening with women in business?

**WOMEN IN THE DRIVING SEAT** Women in business in Australia have not yet reached critical mass. We must speak out and take firm action to increase the numbers of capable women in the driving seat.

**T**he issue of women's participation in the workforce has been a keen topic of public policy as well as private observation for many decades now. And from the time when women were required to resign from their jobs if they married – a statute not repealed for the Australian Public Service until 1966 – we have come a long way.

So why is there not yet a critical mass of women business leaders in Australia? One major factor is that despite the landmark equal pay decisions by the Conciliation and Arbitration Commission in 1969 and 1972, as well as passage of the *Sex Discrimination Act* in 1984, there is still a significant gender pay gap between men and women performing same roles in the Australian workforce.

The Workplace Gender Equality Agency (WGEA) has consolidated a useful range of ABS gender workplace statistics, while KPMG in October 2016 issued an update to its 2009 report into the issue. Fortunately, this pay gap inequality problem is starting to be addressed in a more systematic fashion as company leaders examine their own payroll data.

The authors' experience in Australian and international companies they have worked in is that much of what has led to this current imbalance appears to be the result of unconscious bias – 'We are unaware, so we don't think to look'. Once a problem is quantified though, business executives generally put in place action plans to redress the imbalance.

## WOMEN AS BOARD DIRECTORS

Let's examine the business sector systematically, starting at board level. Among Australia's listed firms, in 2009 women made

up a token 8.3 per cent of non-executive directors on ASX200 companies. Following this, the Australian Institute of Company Directors (AICD) put in place a Chairmen's Mentoring Program to grow the number of 'board ready' women, and more recently set a target of reaching 30 per cent women on ASX200 boards by 2018. The ASX Corporate Governance Council's requirements on diversity reporting have also helped to raise awareness.

Following sustained publicity targeting the leaders of corporate Australia, the women on boards figure has currently reached 25 per cent – although AICD has noted that the 2018 target will only be attainable if the current rate of 40 per cent of new appointments being female continues until then.

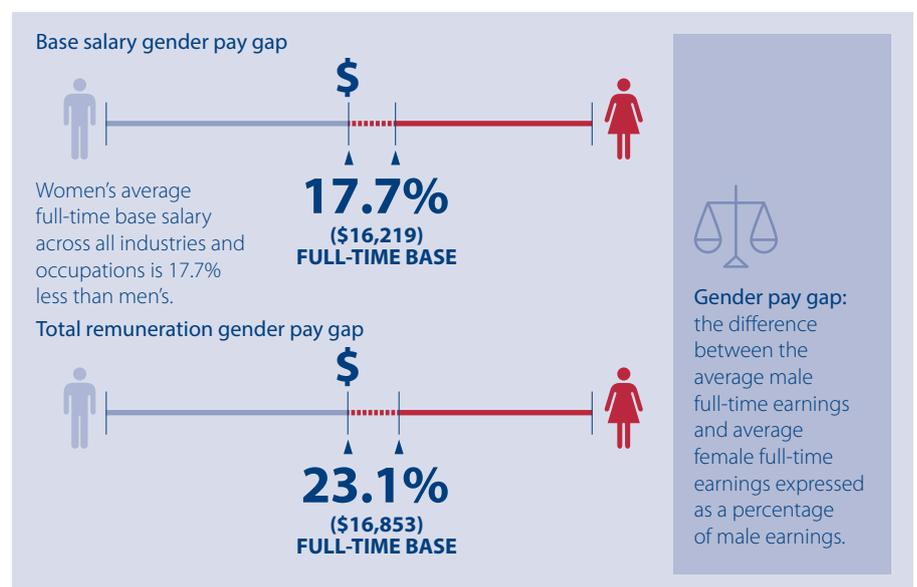
Unfortunately, working in the opposite direction was the fact that among the 23 companies making initial public offerings (IPOs) in the second quarter of 2015-16 only seven per cent of board members were women, while AICD statistics showed 20 ASX200 companies still had no woman on their board.

Is it any wonder that after years of resisting the idea of quotas, prominent business women are starting to say that the only fair target to introduce is 50 per cent?

## WOMEN IN THE 'C-SUITE'

Given that serving on a listed company board requires director candidates to have significant work and executive experience, the discussion in Australia soon turned to the

Figure 1 Australia's Gender Equality Scorecard – overall gender pay gap for base salary and total remuneration (excluding CEO salaries).



SOURCE: WORKPLACE GENDER EQUALITY AGENCY, NOVEMBER 2016

inadequately filled pipeline of potential future directors (and CEOs) in the senior executive level of Australian companies – what’s often known in business as the ‘C-Suite’.

(The phrase ‘C-suite’ is widely used to collectively refer to a corporation’s most important senior executives, deriving from the fact that top senior executives’ titles tend to start with the letter ‘C’, as in chief executive officer (CEO), chief operating officer (COO) and chief information officer (CIO).)

By 2016, with some movement in the right direction underway for several years, 15.4 per cent of CEOs and 27.4 per cent of key management personnel were women.

However, it seems the case that, with a few notable exceptions, those women in top company positions primarily fill roles such as communications, human resources and finance, with a dearth of operationally experienced women running national or international business units, which are often the succession planning posts for promotion to a first CEO role.

The KPMG report identified contributory

factors in driving the gender pay gap of 16.2 per cent, which remains pretty much where it was 20 years ago, and which contributes to working women ending up at retirement with superannuation balances at around half that of men. Following its data analysis, the report suggested supporting actions that businesses could use to address the gap.

These include:

- act to redress past remuneration-related gender bias;
- examine the employee lifecycle to see how to amend business processes in pursuit of greater equality;
- focus on the ‘caring years’ of early to mid-30s to retain employees who take time out to raise families, to ensure their return is sustainable; and
- strive for the right organisational culture to drive out the negative behaviours.

**MAKING A DIFFERENCE?**

So how do we ensure that Australian businesses will actually take action to improve

things, both to reduce the remuneration gap and grow and support a pipeline of women managers who will be the next generation company leaders? Fortunately, setting a good example, we now have the Male Champions of Change (MCC), a collaborative initiative of corporate and institutional leaders, convened by former Sex Discrimination Commissioner Elizabeth Broderick in 2010 following the recognition that the most senior men in organisations with sub-optimal gender balances are the ones best positioned to do something about it.

These influential leaders see their role as stepping up beside women and saying “the promotion of gender equality is everyone’s business”. Importantly, they stand up to be counted, reporting annually against the progress of their businesses against four interconnected themes.

Influential advocacy groups Chief Executive Women and Women on Boards also promote gender equality in business.

Drawing from both the MCC and other

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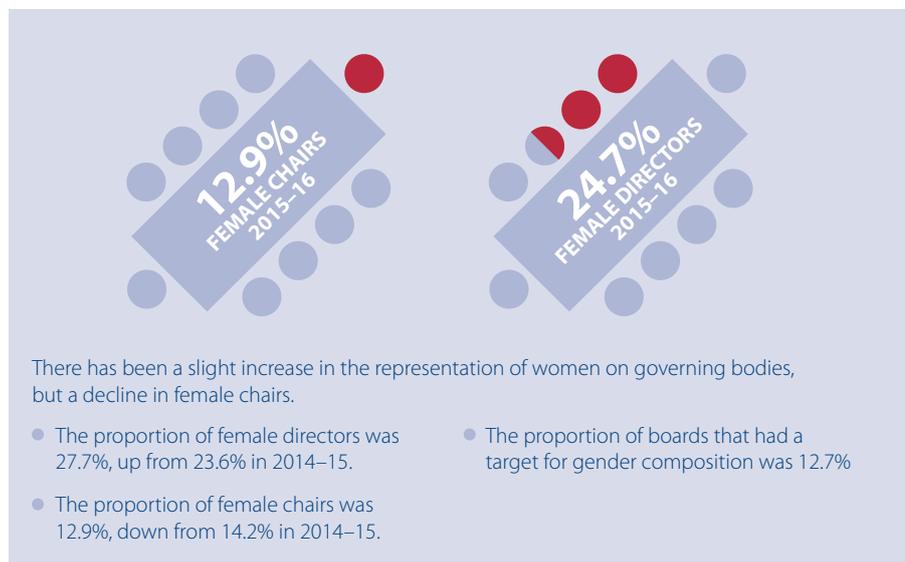
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Professor Doug Hilton

Figure 2 Australia's Gender Equality Scorecard – women's representation on governing bodies.



SOURCE: WORKPLACE GENDER EQUALITY AGENCY, NOVEMBER 2016

relevant literature, once awareness of gender inequality has been raised, and there is a senior champion in the organisation (preferably the CEO), the rate of progress towards gender equality will depend crucially on the quality of the initiatives being put in place company-wide, and close tracking of progress.

A prominent MCC, Professor Doug Hilton FAA FTSE, has been praised for the initiatives he has introduced into the Walter and Eliza Hall Institute of Medical Research, aimed at improving the representation of women at leadership levels in a field where more than half of early career medical researchers are female.

Measures put in place included five-year fellowships for female laboratory heads, leadership training and mentoring, maternity leave cover, contract extensions and childcare support for women with young children, and ensuring workplace flexibility for people with family commitments.

The policies quickly contributed to a 20 per cent increase in the proportion of female laboratory heads at the Institute. Similar success stories are available in any number of the 106 companies recognised in the 2016 WGEA Employer of Choice for Gender Equality Citations.

Despite more rigorous criteria from 2016, the list of businesses cited for genuine improvement is growing every year but, most importantly, companies are increasingly embracing their WGEA tracking and reporting obligations as the norm – an integral part of

their business improvement strategy rather than a compliance task.

In a much larger organisation, with more than 3500 employees in Australia, the Boeing Company is on the same journey towards gender equality, and like many others progress is steady but challenging. Nevertheless since 2014, and for the first time, the regional President of Boeing Australia and South Pacific has been a woman. Maureen Dougherty is an electrical engineer with more than 35 years' experience across the global aerospace and defence sectors. In particular Boeing Defence Australia (BDA), based in Brisbane, has grown by upwards of 800 people over the past four to five years (including many hundreds of engineering recruits at all levels) and is running hard with a gender equality strategy during this growth phase with the goal of making a tangible difference to the gender demographic.

Key strategic objectives for BDA have included: setting targets for gender composition at all levels over a multi-year period; attracting more women to apply; recruiting more women; retaining women; providing enhanced learning and leadership development opportunities for women; increasing female representation on governing bodies; ongoing review and commitment to equal remuneration; more flexible working arrangements; and greater employee consultation on gender equality issues.

The needle is moving and there are some very positive signs demonstrating that the

organisation and sector is becoming more attractive and rewarding as a career option for women.

For example more than a third of all applicants for roles at BDA are now female. And there have been a number of targeted internship, graduate, and higher education recruiting programs implemented with key universities (such as the University of Queensland and Queensland University of Technology) over recent years that have resulted in the highest intake of female engineers in the company's history.

Recruiting practices have changed, the CEO is driving a markedly enhanced leadership culture around gender equality, and managers are being measured on their diversity performance in balance with other key business objectives.

## THE ATSE ROLE

ATSE can play a key role in the quest to increase the numbers of women in business at all levels.

For example, it can ensure that engaging science, technology, engineering and mathematics (STEM) education (reaching more students, starting earlier and lasting longer) becomes a strong public policy cornerstone.

Figures show STEM participation has slipped in recent years, yet STEM training is extremely useful not only to produce a more capable workforce in general, but to project both men and women into senior company roles, particularly in industrial companies. 

*Dr Rosalind Dubs FTSE is a company director, serving on a number of boards including ATSE, Aristocrat Leisure Ltd and ASC Pty Ltd. Her career has spanned a range of industries in publicly listed, private and government companies. With extensive operational experience in the aviation, transport and engineering sectors, she managed large engineering businesses in Germany, France and Australia for Thales SA. Having also worked in CSIRO and held leadership positions within universities, Dr Dubs devotes considerable effort to encouraging research-industry collaboration and promoting the economic benefit of women in senior business roles. She is a member of the ATSE Gender Equity Working Group.*

*Mr Michael Edwards FTSE is the GM of Boeing Research and Technology Australia and carries executive responsibility for the delivery of Boeing's research portfolio in the region. BR&T – Australia is the largest international research centre for Boeing outside the US and collaborates with aerospace research institutions around the country. Prior to joining Boeing in 2011 he worked with the CSIRO for 11 years and for some 15 years prior to that in the plastics, chemicals and petrochemicals industries in Australia. He is a member of the ATSE Gender Equity Working Group.*



## 2017 ATSE NATIONAL TECHNOLOGY CHALLENGES DIALOGUE

# 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.**

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*.

Registrations open end of February. For more information on the Dinner, Dialogue or sponsorship packages visit [www.atse.org.au/ageing](http://www.atse.org.au/ageing)  
Specific enquiries regarding sponsorship email [sue.wickham@atse.org.au](mailto:sue.wickham@atse.org.au)

### DETAILS

Wednesday 14 June 2017  
Brisbane City Hall  
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\$160 per person or \$1,440 for a table of 10

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

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# Driving change in our universities – starting with engineering

**WOMEN IN THE DRIVING SEAT** A number of engineering faculties have started diversity programs, but we need to better understand the reasons behind individual choice.

**P**articipation in engineering degree programs in Australia has historically been dominated by men. There are three principle reasons to address this imbalance.

First, we know that results and solutions are improved if people with a diverse range of skills and bringing a diversity of experiences are allowed to contribute to decision making processes. Quality is enhanced by diversity. This is also true for engineering.

Second, the purpose of engineering as intrinsically a service profession is to benefit society. To achieve this effectively, the makeup of the engineering workforce needs to reflect the society it seeks to serve.

Third, we aim to attract the highest achieving students into our degree programs while simultaneously growing the number of students enrolled. To continue to do so, we must draw our students from the whole population, both male and female.

The universities, the engineering profession and the wider community will all benefit from a more equitable balance of male and female engineers.

To compound the problem, the proportion of female domestic\* bachelor graduates has declined over the past decade, although there is significant variation between universities. The proportion of women among international students in all cohorts is above that recruited domestically.

In contrast to the undergraduate numbers, the proportion of female doctoral

graduates has increased slightly and the proportion of female domestic coursework masters graduates has remained more or less constant, although there is considerable year-to-year variation at the postgraduate level. These trends are shown in Figure 1.

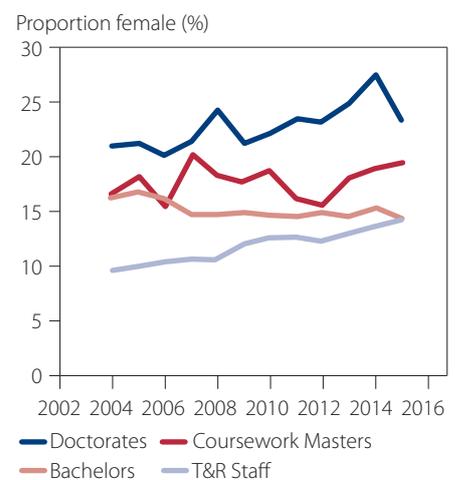
While the proportion of domestic female bachelor of engineering (BE) graduates declined to 14.3 per cent in 2015, the absolute number has increased over this time (Figure 1) by 12 per cent to 1092. However, the number of male graduates has increased by 31 per cent – the number of male graduates is increasing much faster than the number of female graduates.

These numbers are in stark contrast to those for other professions such as medicine, where 51 per cent of domestic graduates in 2014 were women (1592 of 3121), according to university records.

The problem does not lie in the pipeline of prospective students, contrary to common belief. *The Decadal Plan: The Mathematical Sciences in Australia – A Vision for 2025* recommends that Australian universities reintroduce Year 12 Intermediate Mathematics as a prerequisite for all bachelors programs in engineering. A number of Australian universities, but not all, satisfy this recommendation already.

With this requirement, what does the pipeline into engineering look like for girls? A recent report (Barrington and Evans, September 2016) shows that boys' participation rate in Intermediate Mathematics is around 20 per cent while that for girls is

**Figure 1** The proportion of women in Teaching and Research Academic positions and the proportion of domestic female graduates in doctoral, coursework masters and bachelors programs between 2004 and 2015.



SOURCE: ACED

around 18 per cent. This suggests that the pipeline for girls into engineering is not too dissimilar to that for boys, yet girls do not go on to choose engineering at the same rate.

The problem is also neither one of success nor retention. The aggregated data (Table 1) for Australian engineering schools shows that women have a higher success rate (the proportion of courses/subjects passed by a student in a given year), a higher institutional retention rate (retention in the institution but not in engineering) and a higher engineering retention rate (retention within the degree) than men for both commencing students and continuing students (that is, first year versus later year students). The impact of better

\* A domestic student is either an Australian citizen, a New Zealand citizen, an Australian permanent resident or an Australian humanitarian visa holder. Others are international students.

**Table 1 Success and retention rate (%) for undergraduate engineering students in 2014, the last year for which a full data set is available. Earlier years show similar trends.**

Success rate	Bachelors % domestic female full-time overall	89.8
	Bachelors % domestic male full-time overall	86.7
	Bachelors % domestic female full-time commencing	87.5
	Bachelors % domestic male full-time commencing	83.3
Institution retention	Bachelors % domestic female full-time overall	92.1
	Bachelors % domestic male full-time overall	89.0
	Bachelors % domestic female full-time commencing	90.7
	Bachelors % domestic male full-time commencing	87.8
Engineering retention	Bachelors % domestic female full-time overall	88.2
	Bachelors % domestic male full-time overall	86.2
	Bachelors % domestic female full-time commencing	85.3
	Bachelors % domestic male full-time commencing	83.5

**Table 2 The 2016 graduation numbers for two Go8 universities, including domestic and international students.**

Program	Total graduating students, male & female (number)		Female (%)	
	University 1	University 2	University 1	University 2
Biomedical Engineering	-	40	-	48%
Environmental Engineering	23	33	43%	36%
Chemical Engineering	68	63	41%	37%
Civil Engineering	112	122	29%	24%
Electrical Engineering	48	118	23%	24%
Software Engineering	16	47	13%	19%
Mechatronics Engineering	-	38	-	18%
Structural Engineering	-	47	-	15%
Mechanical Engineering	86	98	12%	13%
Computer Engineering	8	-	0%	-
TOTAL (includes composite & dual degrees)	527	680	26%	25%

*The future of engineering?*



female outcomes is that there is a greater proportion of female graduates than there are enrolling students.

It is commonly observed that female enrolments very much depend on the sub-discipline. Thus female enrolments in Chemical Engineering and Environmental Engineering typically exceed 40 per cent and enrolments in Biomedical Engineering can sometimes exceed 50 per cent.

In contrast, female enrolments in Civil

and Electrical Engineering are typically at the average, while Mechanical and Computer Engineering are well below the average.

For example, the graduating numbers for two Go8 universities are shown in Table 2. The problem is therefore not recruiting female students into engineering generally but recruiting women into certain disciplines of engineering, as only a few disciplines approach gender parity. Some of the reasons for these substantial differences by discipline

may be the curriculum, the pedagogy, the lack of role models and the lack of other women in the cohort.

To increase female enrolments in engineering generally, best practice from institutions here and abroad suggest that universities should:

- establish a Women in Engineering committee with strong senior leadership to ensure that buy-in and program support is achieved across disciplines;
- provide role models through a targeted campaign that seeks to recruit female engineers into senior academic positions;
- appoint a marketing and communications manager to implement a school outreach program that specifically focuses on recruitment of female engineering students;
- provide networking events for female engineering students;
- develop a mentoring program that is specific to women engineering students with mentors sourced from both academia and industry; and
- promote gender-inclusive teaching practices to all teaching staff.

A number of engineering faculties have recently initiated diversity programs, which are beginning to have an impact.

For example, The University of Queensland introduced its Women in Engineering strategy in 2012 with significant financial support from Rio Tinto, the Australian Petroleum Production and Exploration Association (APPEA) and the Australian Power Institute (API). It now has a dedicated Women in Engineering recruitment team and has seen enrolments increase by three per cent to 22 per cent. UQ recently hosted a collaborative workshop with attendees from 18 universities to enhance knowledge-sharing and best practice.

The University of New South Wales has also established a Women in Engineering team with significant industry funding and led the groundbreaking 'Made By Me' social media campaign.

This is a collaborative project between eight universities and Engineers Australia to change the image of engineering among young people. The goal is to depict engineering as a future-looking, creative, meaningful and essential profession, and make it more attractive to students who would not have otherwise considered it,

particularly girls. The campaign makes use of an interactive music video coupled with a microsite ([madebyme.org.au](http://madebyme.org.au)) containing information linking everyday objects to the engineering behind them and featuring profiles of 22 engineers (73 per cent female); and a public relations effort aimed at reaching influencers such as parents and teachers through traditional media and news.

While it is too early to gauge the effectiveness of the campaign, early indicators are very encouraging, with 114 pieces of media coverage in the first month and over 1.2 million views by late 2016, of which 80 per cent were from within Australia.

It is clear that universities, and hence the nation, have a collective problem regarding the inhomogeneity of the engineering student cohort. While some universities are making serious attempts to address the issues, cultural change does not happen quickly.

Part of the problem is the lack of comparable data by institution and discipline, which is challenging to collect. Also lacking is accurate and validated information on what drives student choice and therefore strategies are developed and decisions made

on intuition and good intentions.

To properly address the problem, we need to better understand the reasons behind individual choice.

Among other things, this will require a broad-based, sector-wide national survey of current female engineering students and recent engineering graduates, as well as students who chose to study other disciplines although they met the requirements for entry to engineering. ☺

*Professor Graham Schaffer FTSE is Professor of Materials and Design in the School of Engineering, University of Melbourne. He was previously the Pro Vice-Chancellor for the College of Science, Health and Engineering at La Trobe University and Executive Dean of Engineering, Architecture and Information Technology at The University of Queensland. His current research interests are focused on the design process and the flow of knowledge in engineering design teams; the development of a materials design heuristic; and the design of materials for additive manufacturing. He has BSc and MSc degrees from the University of Cape Town and a PhD from the University of Birmingham.*

*Ms Else Shepherd AM FTSE is an Adjunct Professor and CEO in Residence at QUT. An electrical engineer, she co-founded two companies specialising in innovative telecommunication products. She is an Honorary*

*Fellow of the Institution of Engineers and a Fellow of the Queensland Academy of Arts and Sciences. She was The University of Queensland Alumnus of the Year 2009 and in 2011 was awarded an Honorary Doctorate of Engineering by The University of Queensland. She was Chairman of Powerlink Queensland for 17 years and a Director of NEMMCO for 13 years. She has held Directorships of a range of engineering companies and also not-for-profit and music organisations.*

*Professor Doreen Thomas FTSE is Head of the School of Electrical, Mechanical and Infrastructure Engineering and Associate Dean Research and Research Training for the School of Engineering, University of Melbourne. She has a BSc Hons from the University of Witwatersrand and an MSc and DPhil in Mathematics at St Anne's College, University of Oxford. She has applied her fundamental mathematical research in network optimisation to applications as diverse as the bionic eye; infrastructure for electric vehicles and underground mine design. She has also been recognised with a national teaching award for engineering education and mentorship.*

*Professor Mark Hoffman FTSE is the Dean of Engineering at UNSW. Prior to this he was UNSW's Pro Vice-Chancellor (Research), Associate Dean (Research) in the Faculty of Science, Head of the School for Materials Science and Engineering and Presiding Member of the University's Committee on Research. He holds a BE and PhD from the University of Sydney and Masters of Business and Technology from UNSW. He is an Associate Editor of the Journal of the American Ceramic Society and was awarded a Carrick Citation for outstanding contributions to student learning.*

## EMMA JOHNSTON NAMED UNSW SCIENCE DEAN

The University of NSW has named Professor Emma Johnston, currently Pro Vice Chancellor (Research) as Dean of Science, from May.

Professor Johnston is a leading authority in marine ecology and her research has been recognised with numerous awards, including the 2014 Nancy Millis Medal for Women in Science, the 2012 NSW Science and Engineering Award for Excellence in Biological Sciences and the Hynes Award from the Canadian Rivers Institute (2016).

In 2012, Professor Johnston was appointed the inaugural director of the Sydney Harbour Research Program at the Sydney Institute of Marine Science. As head of the Applied Marine and Estuarine Ecology Laboratory at UNSW, she has led more than 20 major research projects for industry, government, the Australian Research Council and the Australian Antarctic Science Program.

Professor Johnston is a high-profile science communicator, winning the 2015 Eureka Prize for Promoting Understanding of Australian Science Research. She is a regular media commentator and, as co-presenter for the Foxtel/BBC television series *Coast Australia* has helped take Australian marine science to an international audience.

As a leading authority in her field and a skilled communicator, Professor Johnston has engaged with government and industry to influence policy. She is also an effective advocate for gender equity in science. She is currently Vice-President of Science and Technology Australia and recently won the Emerging Leader Award in *The Australian Financial Review* 2016 Higher Education Awards.



PHOTO: JACKY GHOSSEIN

Emma Johnston

CONTRIBUTIONS  
ARE WELCOME

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BY KATHRYN FAGG  
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# Changing the way we do things

**WOMEN IN THE DRIVING SEAT** Everyone in organisations knows which roles are the most important. We need to have a critical mass of women in them.

A

As we enter 2017 it seems like a time to reflect for those of us seeking to bring about social change, given the political pressures that we are seeing around the world.

As we seek to increase gender diversity and create more opportunities for talented women, we need to be aware that we are looking to change the way things are done, which can be uncomfortable.

I believe the reason we are seeking to increase the role of women – whether in the Academy or elsewhere – is that we want to create a better society for Australians and that means we have to draw on all the talent that is available, both men and women.

We do need to be respectful as we seek to bring about change and consider others' views.

However, we also need to recognise where there has been success. Two of my favourite places where I see this happening are the increasing number of women on boards and the increasing number of younger women who are choosing to study engineering.

In both of these very different cases, it has been leadership that has been the key to transforming the profiles of the boards of our largest companies and of our undergraduate intake.



*We need a 'critical mass' of women.*

In the area of boards, the proportion of women board members in the ASX200 is now at 25 per cent. This compares with just eight per cent back in 2008, which was when there was a wake-up call that something needed to be done, as the representation of women actually went backwards.

Senior leaders – including many men – stepped up and sought to change things. More recently, The *30% Club* has been launched in Australia and supported by the Australian Institute of Company Directors with the goal of achieving 30 per cent of the ASX200 board members being women by 2018.

And the good news is that the appointment rate of women to these boards was running at 40 per cent in 2016 – and, for those of us who love numbers, that is the run rate required to achieve the 2018 target. Leadership and targets can work wonders.

It is terrific to see the progress being made on the board front. However, the much greater challenge is increasing the number of women in the most senior executive

roles – which have the most influence and decision-making power in organisations. In our commercial organisations, this means we need to see more women in roles such as Chief Executive Officer (CEO), Chief Financial Officer (CFO) and Business Unit Heads.

In late 2016, I became President of Chief Executive Women (CEW), the organisation that represents more than 400 of Australia's most senior women from the corporate, public, academic and not-for-profit sectors. The organisation's mission is "women leaders enabling women leaders".

As CEW's President, I have set myself the goal of having an impact on the rate of appointment of women to the most senior executive roles in organisations, and not just appointment to senior support roles. Everyone in organisations knows which roles are the most important. We need to have a critical mass of women in them.

Once again the key is going to be leadership. Although there are no silver bullets, we know what is required. Leaders

LETTERS TO THE  
EDITOR  
FOCUS



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must be able to communicate a compelling case for change, to build a top team with gender diversity, to play a strong role in key recruitment and promotion decisions, to set challenging targets and to act as a sponsor for talented women and men.

On this last element – acting as a sponsor – research over recent years has brought to the fore just how important this is. Most of us can think back to people who really made a difference in the trajectory of our careers. For those wondering about the distinction between a sponsor and a mentor – a sponsor is in a position of authority who can use her/his influence to help others advance, while a mentor gives advice to an individual. Both sponsors and mentors are important and

valuable – but sponsors can directly assist career progression.

Often a discussion around sponsorship leads to a question of whether it is consistent with the concepts of merit and meritocracy. The answer is merit should be the basis for appointments but sponsorship can help ensure the right people are considered.

It is also important to recognise that great care needs to be taken when looking at ‘merit’.

Last year, Chief Executive Women along with the Male Champions of Change released a report on avoiding the ‘merit trap’, because organisations that pride themselves on being a meritocracy can be at greater risk of their judgements and actions being biased.

In particular, it is critical to look at both performance and potential when considering candidates for appointment. We also need to be careful to avoid defining ‘merit’ as ‘people like us’.

For organisations, one of the challenges is to look beyond individual merit and consider institutional merit. One of my favourite quotes on the topic comes from Lieutenant General Angus Campbell, Chief of Army, who reflects on the difference between individual merit and institutional merit: “Institutional merit is not the same as individual merit. If you choose a senior executive team based only on individual merit, you get a monologue. Institutional merit creates a strong diverse Army, not a strong list of individuals.”

Often when I am challenged on why we might be looking for a woman (or for that matter, a man, for one organisation where I am on the board which is very female-oriented) and not just ‘the best person for the job’, it is by focusing on institutional merit that the quest for greater diversity seems to be accepted.

The Academy of Technology and Engineering provides a wonderful example of how an institution has been strengthened by the greater involvement of women – as Fellows and in roles of responsibility with its Board, Assembly, Divisions, Committees and Forums.

I have confidence that we will have a better society when we fully draw on the talent of all of our people. And we can all take great pride in the role of the Academy as a leader and role model for bringing about change and increasing gender diversity. 

## UNSW ENGINEERING OFFERS 25 PER CENT OF PLACES TO WOMEN

The University of NSW offered a record number of engineering places to female students this year – one in four engineering offers went to female school leavers.

“In 2013, 19 per cent of main round offers went to female students. To see that grow to 25 per cent for 2017 is just incredible,” says UNSW’s Women in Engineering Manager Dr Alex Bannigan.

“These numbers show that there is no lack of interest in STEM disciplines among women – once they know about the opportunities presented by a career in engineering, there are plenty of women keen to pursue it.”

UNSW Engineering has set a target to boost that rate to 30 per cent by the end of the decade. To do so, it has been actively recruiting female students and running STEM outreach programs, including its Women in Engineering (WIE) Summer Camp for senior high school students.

Introduced this year, UNSW’s Head-Start Awards, valued at \$3000 each, go to the 60 highest-ranked commencing students. This is in addition to 15 WIE program scholarships, 10 of which are sponsored by industry.



Brittney Monk and Laura Johnson are among a record number of female students to receive offers to study engineering at UNSW in 2017.

### FURTHER READING

Chief Executive Women and Male Champions of Change, *It starts with us – the Leadership Shadow*, 2014

Chief Executive Women and Male Champions of Change, *In the Eye of the Beholder – Avoiding the Merit Trap*, 2016

*Ms Kathryn Fagg FTSE is an experienced chairman and board member. She has worked in senior executive roles across a range of industries – resources, manufacturing, logistics, banking and professional services – in Australia, New Zealand and Asia. She has been a member of the board of the Reserve Bank of Australia since 2013. She is also on the boards of ASX-listed companies Boral, Djerriwarrh Investments and Incitec Pivot. She is President of Chief Executive Women and Chairman of the Melbourne Recital Centre and Breast Cancer Network Australia (BCNA). She was Chairman of Parks Victoria, is a board member for the Australian Centre for Innovation and chairs the Academy’s Industry and Innovation Forum.*



BY MARK TONER  
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# Why aren't there more women running higher education?

**WOMEN IN THE DRIVING SEAT** In general, patriarchy isn't an explicit ongoing effort by men to dominate women; it's a long-standing system that we are born into, accept and participate in, mostly unconsciously.

**F** For more than 30 years, since 1985, more women have graduated from Australian universities than men.

For the past three years the difference has been more than 20,000.

So, even after allowing for women to have career breaks to manage family issues, wouldn't it be reasonable to expect universities to have at least similar numbers of men and women in the top management ranks?

Table 1 shows the relevant numbers at the end of 2016 from Universities Australia's website.

Apart from the DVC (Academic) role, men far outnumber women in these senior positions.

Why aren't there more women in senior roles in higher education (HE)?

Possible reasons are the following.

- 1 Women aren't as interested in senior roles as men.
- 2 Women don't perform well in senior roles compared with men.
- 3 There aren't enough women available for these roles.
- 4 Women don't apply for these roles as much as men do – some take career breaks for family reasons and some underestimate their ability to do the job.
- 5 Some of the men in charge favour men and discriminate against women. (There is also evidence that some senior women discriminate against other women.)

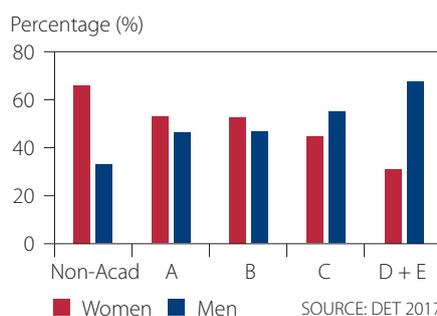
Much research has been carried out on the first two reasons, and there is no evidence that they are true in general.

The third reason is believed by many

**Table 1 Australian universities senior management gender analysis 2016.**

Position	Women (%)
Chancellor	15
Vice Chancellor	28
Deputy Vice Chancellor (Academic)	54
Deputy Vice Chancellor (Corporate)	15
Deputy Vice Chancellor (Research)	37
Deputy Vice Chancellor (International)	33

**Figure 1 Gender analysis of higher education staff (full time and fractional full time) roles in 2016.**



people to be a factor, but given the excess (20,000 over the past three years) of female graduates over male graduates in the past 30 years, this is also not true in general.

Because of their caring responsibilities for children and wider family members, some women may not be as mobile as men to take up new positions away from their home base.

However, there is more data available.

Figure 1 shows percentages by gender of non-academic and academic staff in Australia. Australian Department of Education and Training statistics show that in Australia's HE institutions there are more than four times

the number of women at academic levels A, B and C (19,638) than at D and E (4813), so there is no shortage of available talent, given that women do perform as well as men in senior roles. It is therefore hard to accept that the third reason above has validity. Perhaps for regional institutions it is more relevant.

The fourth possible reason (that women don't apply for senior roles as much as men do, because some take career breaks for family reasons) does have validity, as does the contributing factor that some women underestimate their ability to do a more senior job.

There is considerable research showing that men tend to overestimate their abilities and performance, while women underestimate theirs (even though their performances do not differ in quality). This leads to men typically applying for a job when they have perhaps 50 to 70 per cent of the required skills, whereas women need about 90 to 110 per cent. (These are findings about women in general and they do not apply to any particular individual.)

So the question now is: does this fourth reason alone explain the low number of women in senior academic positions? The gap between the numbers of men and women in these roles is so large that this fourth reason alone is insufficient to explain it.

Therefore the inevitable conclusion is that the fifth reason – that men discriminate against women – is the major cause of this large discrepancy in numbers.

Men favouring men is the major characteristic of a patriarchal system, so let's look at the characteristics of such systems. They typically:

# 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.

- hold traditional male qualities as central (for example, power, control, rationality and extreme competitiveness) while other qualities are subordinate (for example, emotional expressiveness, compassion, empathy and ability to nurture members);
- have gendered roles (that is, men lead and women support – and get paid or rewarded less);
- demand that men generally occupy the most important and visible roles (for example, senior executives, politicians, public leaders). Women who do hold these positions are expected to support and subscribe to male norms; and
- maintain traditional patriarchal social structures through a high level of control by male leaders. Control is sometimes assisted by generating fear.

In governments, religions, professions, business, communities, education and sport, patriarchy is the status quo. In general, patriarchy is not an explicit ongoing effort by men to dominate women. It is a long-standing system that we are born into, accept and participate in, mostly unconsciously.

So Australian HE institutions are patriarchal systems. What can be done to remedy this situation, given that there are so many talented women suitable for senior positions?

One important recent initiative is the introduction of the Science in Australia Gender Equity (SAGE) Pilot Program to Australia. SAGE is run by a partnership between ATSE and the Australian Academy of Science, adapting the UK Athena SWAN framework to suit Australia's conditions and equality challenges, and is supported by funding from the Australian Government.

But HE institutions need to tackle their lack of women in senior positions not just to be accredited in the SAGE program but, more importantly, to improve their organisational culture and effectiveness.

To do this, HE senior management needs to address two major issues:

- a lack of understanding in senior management of relevant male/female differences; and
- cognitive bias (both conscious and unconscious) in favour of men and against women.

There are some clearly established male/female personality and behavioural differences, and self-estimation of ability



Otago University – New Zealand's oldest – is led by VC Professor Harlene Hayne.

and performance (mentioned above) is one. Another is lower self-confidence of women in general. These two male/female differences alone cause women to be disadvantaged in typical HE recruitment and promotion processes, and steps need to be taken by senior management to allow for these differences.

How cognitive bias disadvantages female applicants in recruitment and promotion processes was described in *Focus 194* (February 2016, page 5). As an example, in-group bias causes us to favour people of our own skin colour, ethnicity, gender, age, and so on – and people with similar interests or experiences to ourselves.

On the other hand, out-group bias causes us to be uncomfortable with, and act to avoid and disadvantage, people who are not like us. In the extreme, we fear people who are not like us, which is xenophobia.

In-group/out-group bias is strong in all of us because it's hard-wired in our brains from evolution. So in general, men favour men both unconsciously and consciously, and hence patriarchal organisations continue to thrive, as they have for millennia.

To get more women into senior academic positions, HE institutions should:

- ensure that the advertised role is described in a gender-neutral way;
- issue gender-neutral and ethnicity-neutral recruitment and promotion policies and procedures, and ensure they are followed;
- organise discussions on 'merit' (a subjective concept very susceptible to bias);
- organise removal of identity data for shortlisting candidates, if possible;
- proactively identify and encourage suitable women to apply for positions and promotions; and
- provide coaching on how to write an appropriate CV and application.

Recruitment and promotion panel members should:

- set up clear, non-gendered judging criteria;
- take into account male/female differences – for example, awareness of gender stereotypes, self-estimation differences between men and women, self-confidence being a substitute for competence, and a tendency to assess men on potential and women on past performance;
- understand the major biases relevant to recruitment and promotion decisions, the causes of bias and its mitigation; and
- discuss their own and other members' biases before and after making decisions about people, in a transparent process.

The Australian Government's National Innovation and Science Agenda notes that 75 per cent of all jobs in Australia's fastest growing industries require STEM skilled workers. In the STEM sector, the number of senior female academics is relatively far lower than across HE institutions generally, which means the lack of senior female academics in STEM needs to be addressed even more urgently.

ATSE is playing its part by running SAGE with the Academy of Science, by following a strict gender equity policy which demands, inter alia, that ATSE works only with institutions which have their own gender policy and that ATSE maintains a minimum target of 33 per cent of new Fellows being women. ☺

*Dr Mark Toner FTSE is Chair of ATSE's Gender Equity Working Group. He is a consultant with Gender Matters, which advises organisations on gender equity issues and provides training in cognitive bias mitigation. A former CEO of the engineering and construction company Kvaerner (now Jacobs) Australia, Dr Toner is a past President of the Business/Higher Education Round Table. He has been a company director for more than 25 years in the STEM and IT sectors.*



BY SUSAN POND  
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# SAGE is driving gender equality and social good

**WOMEN IN THE DRIVING SEAT** The Athena SWAN principles and programs such as SAGE are relevant in any societal, political and economic context and for every woman and girl, man and boy in Australia.

**S** Study after study in countries around the world and in Australia has demonstrated immaterial differences in the innate intellectual abilities of boys and girls, including in mathematics.

And yet, with the exception of medicine, young women in Australia are under-represented in STEM fields of undergraduate study, evidenced by the fact that 80 per cent of graduates in computing, engineering, manufacturing and construction are male, as are 60 per cent of graduates in science, mathematics, statistics and physical sciences.

From these baselines, gender gaps in STEM disciplines (including medicine) widen considerably in our universities as graduates continue along the trajectory to senior academic levels represented at Levels A (tutor) to E (professor) as set out in Figures 1 to 3.

Currently, at the very top, there are 11 female and 28 male vice-chancellors in Australia's universities.

The figures are similar for Australia's independent medical research institutes where, currently, there are 11 female and 36 male directors.

When the then new Director of the Walter and Eliza Hall Institute of Medical Research (WEHI), Professor Doug Hilton FAA FTSE, chaired his first meeting of senior academic staff in 2009, every single one of the 20 department heads or professors in the room was male.

Writing in *Nature* in 2015, Professor Hilton noted the progress as a result of the actions to address gender inequality taken at WEHI: "We now have four female professors or department heads. That is hardly a reason

for wild celebration, but given that we began from such a woeful base it is a start."

Changing the workforce and culture of any organisation is a slow process.

## MERITOCRACIES

Universities and research institutions represent themselves as meritocracies and profess to use meritocracy as the main principle for appointing and promoting their workforce. In which case, do gender inequalities arise because women failing to measure up or are the organisations failing to women? The evidence overwhelmingly points to the latter being the case.

In their 24 August 2016 report *The Eye of the Beholder*, two Australian leadership groups, Chief Executive Women and Male Champions of Change, noted that the more an organisation described itself as a meritocracy, the greater the bias from managers towards men over equally qualified women.

"Many studies confirm that we are drawn to those who think, look and act like us" it noted. In other words, women are not afforded the same opportunities to compete as men.

The complex reasons for this opportunity inequality lie in the entrenched institutional systems and cultural traditions that disadvantage women. They are hard to detect and reverse. Many of them result in 'non-events' such as women being overlooked by or inconspicuous to decision-makers, being excluded from core networks at the centre of power, being regarded by decision-makers as representing uncertainty or not sharing similar values and behaviour.

These 'non-events', accumulating and self-reinforcing over time, explain in large part the

leaky pipeline of female talent and the under-representation of women at senior levels.

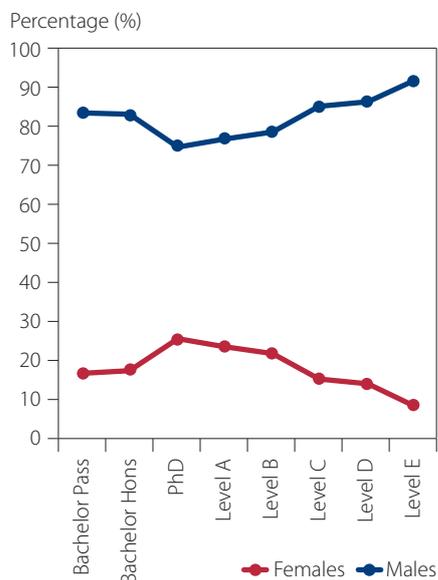
## LEADERSHIP

Science in Australia Gender Equity, led in partnership by AAS and ATSE, was founded to drive disruptive strategies that will significantly move the needle towards gender equality in STEM in Australia's universities and research organisations.

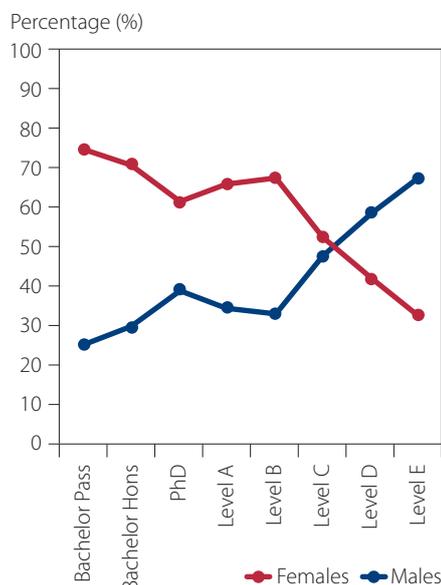
At the core of SAGE is the implementation of the Pilot Program that enables 30 Australian universities, six medical research institutes and four publicly funded research organisations to participate in the Athena SWAN Awards Program.

Established in the UK in 2005 by the Equality Challenge Unit, the Athena SWAN

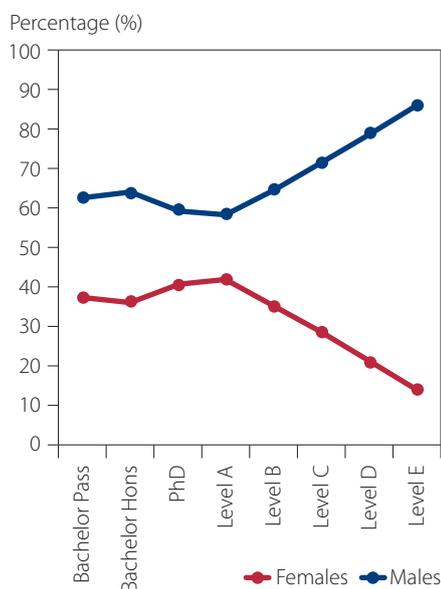
**Figure 1 Gender representation by student completions and academic level Engineering, 2014.**



**Figure 2 Gender representation by student completions and academic level Medical Science and Health, 2014.**



**Figure 3 Gender representation by student completions and academic level All STEM fields (excluding Medical Sciences and Health), 2014.**



**Table 1 The 10 Principles of the Athena SWAN Charter.**

1	Academia cannot reach its full potential unless it can benefit from the talents of all
2	Advancing gender equality in academia across the entire career pipeline
3	Addressing unequal gender representation across academic disciplines and functions
4	Tackling the gender pay gap
5	Removing obstacles to sustainable academic achievement
6	Addressing the negative consequences of short-term contracts
7	Tackling the discriminatory treatment of transgender people
8	Commitment and action from all levels of the organisation, senior leadership
9	Re-designing and mainstreaming sustainable structural, attitudinal and cultural changes
10	Considering the intersection of gender and other factors such as ethnicity

**Table 2 Significant SAGE Milestones.**

Date	Milestone
Feb 2012	ATSE Board implemented target for the first time that 33 per cent of new Fellows elected should be female.
May 2013	AAS confronts a gap in gender equity when its annual selection of Fellows did not include any women.
Nov 2014	AAS hosts the SAGE Forum with sponsorship from the Office of the Australian Chief Scientist. The Forum discussion with 140 experts from higher education and research institutions around Australia was led by the Chief Executive Officer of the Equality Challenge Unit in the UK (owner and operator of the Athena SWAN Charter). Forum participants unanimously agreed to conduct a pilot evaluation of the Athena SWAN Charter and accreditation framework in STEM in Australia.
Apr 2015	Steering Committee established with Brian Schmidt and Nalini Joshi as Co-Chairs. Project team appointed to manage the SAGE Pilot and other gender equity and diversity activities.
Jul 2015	SAGE invitation to participate in the SAGE Pilot of Athena SWAN in Australia led to inclusion of 32 universities, medical research institutes and publicly funded research agencies.
Sep 2015	Agreement executed with the Equality Challenge Unit to pilot Athena SWAN Charter in Australia. ATSE joins SAGE as a partner with AAS. Susan Pond replaces Brian Schmidt as Co-Chair of Steering Committee. SAGE Pilot of the Athena SWAN Charter officially launched at Parliament House, hosted by the Parliamentary Friends of Science and the Parliamentary Friends of Women in Science, Maths and Engineering. The SAGE Launch was attended by Ministers and Senators as well as senior leaders from STEM agencies, and representatives from each of the 32 institutions taking part in the pilot program.
Feb 2016	Pilot implementation initiated with Workshop 1 (Data Analysis and Analysis) – SAGE Pilot of Athena SWAN convened for Cohort 1 (inaugural 20 participants in the Pilot).
Mar 2016	AAS and ATSE establish new governance arrangements for SAGE including Management Board, Executive Director, an Expert Advisory Group and Project Audit and Risk Committee.
May 2016	Australian Government grants SAGE funding of \$2 million over three years under the National Innovation and Science Agenda 'Expanding opportunities for women in science, technology, engineering and mathematics (STEM) and entrepreneurship' initiative. The funding aims to support expansion of the Pilot and its implementation, as well as defining a model to sustain SAGE into the future. SAGE issues a second round of invitations for application to participate in the SAGE Pilot of Athena SWAN in Australia.
Jun 2016	SAGE Inaugural National Symposium convened, attracting some 340 participants. Elizabeth Broderick announced as Chair of SAGE Expert Advisory Group. Eight institutes joined the Pilot of Athena SWAN in Australia, bringing SAGE membership to 40 participants comprising 30 universities, 6 medical research institutes and 4 publicly funded research agencies.
Aug 2016	Workshop 2 (Synthesis and Presentation) – SAGE Pilot of Athena SWAN convened for Cohort 1. Inaugural meeting of the Expert Advisory Group.
Dec 2016	Workshop 1 (Data Analysis & Analysis) – SAGE Pilot of Athena SWAN convened for Cohort 2 (second group of 20 participants in the Pilot).

Science in Australia Gender Equity (SAGE) is national program promoting gender equity and gender diversity in science, technology, engineering, mathematics and medicine (STEMM). The STEMM focus arises from concerns in the Academy of Science (AAS) and Academy of Technology and Engineering (ATSE) – the two Academies leading SAGE – that the numbers do not add up.

Program was designed to address the chronic under-representation of women in STEM at senior levels in UK universities.

This successful program is underpinned by the 10 principles that make up the Athena SWAN Charter (Table 1, page 17).

Leadership from the very top is critical to success of Athena SWAN. Institutions join the Charter with their executive leader signing up the Principles of the Charter.

The institution subsequently works towards an Athena SWAN Award, which in Australia involves more than two years of activities to gather evidence and address gender equity and diversity issues within the organisation. It begins by appointing a team of scientists, students and professional and support staff who collect and analyse data to identify gender and diversity issues within the organisation. Institutions must also consult broadly with their STEM academics, staff and students to identify gaps between policy and practice.

Stringent collection and analysis of an organisation's data on gender equality are critical to the success of Athena SWAN. The insights revealed identify the invisible needs and challenges; the groups facing the biggest barriers to realising their potential and the potential of the organisation; the evidence required to push for change; and the transformative solutions to gender inequality.

### SAGE PROGRESS

SAGE has made substantial and rapid progress to date. Table 2 (page 17) lists the significant milestones.

Acknowledgement of SAGE as a force for change even at the early stages of its life is evident from the market pull for rapid expansion of the Pilot from the originally anticipated six-to-eight institutions to 40, the recognition of and funding for SAGE in the Australian Government's National Innovation and Science Agenda, the collaboration with programs such as Male Champions of Change,

which has recently formed a Male Champions of STEM group, and strong collaboration with the UK's Equality Challenge Unit.

The Athena SWAN principles and programs such as SAGE are relevant in any societal, political and economic context and for every woman and girl, man and boy in Australia.

The impacts on the bottom line of public and private enterprises that have more women in senior leadership positions are proven and positive. The impacts of gender equality on the health and social well-being of women and men are proven and positive. ☺

*Dr Susan Pond AM FTSE is a senior leader in business and academia, recognised for her national and international influence in medicine, biotechnology and renewable energy. Currently, she is Director of Biotron Ltd, Vectus Biosystems Ltd and the Wound Management Innovation CRC, Chair of the Australian Institute for Bioengineering and Nanotechnology at the University of Queensland, Chair of the NSW Smart Sensing Network and Adjunct Professor in Engineering and Information Technologies at the University of Sydney. Dr Pond is a member of the SAGE Expert Advisory Group.*



## Changing the face of engineering

UNSW Women in Engineering Industry Partners are supporting the next generation of female engineers through mentoring, internships and scholarships for high performing school leavers.

Join us on our mission to increase the proportion of women studying engineering to 30% by 2020.

Visit: [unsw.to/wie](http://unsw.to/wie)

*Thanks to our current industry partners: Arup, Atlassian, Boral, Boygues Construction, Commonwealth Bank, Hindmarsh, Infigen Energy, Kimberly-Clark, Onica, Origin Energy, Transurban, WSP|Parsons Brinckerhoff.*



BY DR Wafa EL-ADHAMI AND DR SARAID BILLIARDS  
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# The Government is tackling gender inequality

**WOMEN IN THE DRIVING SEAT** A national effort to overcome the cultural and organisational factors that discourage girls and women from studying in the STEM areas.

**T**ransformative change requires commitment and leadership, people involvement (well beyond engagement) and systematised measurement underpinned by evidence. Collective and persistent actions are paramount where sustainable cultural and behavioural changes are concerned.

These facts are recognised in a number of Australian Government-funded initiatives and investments supporting gender equality in Australia's science, technology, engineering, mathematics and medicine (STEMM) industries – and in Government itself.

SAGE and its Athena SWAN program have received a deal of publicity but perhaps less well-known are Federal Government initiatives in this area.

The National Innovation Science Agenda (NISA), worth \$1.1 billion over four years, covers a range of programs that support women in STEMM.

One program is the provision of \$13 million to support the greater participation of girls and women in the STEM research sector, and STEM industries, start-ups and entrepreneurial firms.

The goal of this support is to implement a national effort to “overcome the cultural and organisational factors that discourage girls and women from studying in the STEM areas, and which subsequently limits their career opportunities,” according to the Minister for Employment and Women, Michaelia Cash.

Another program supports continuing advancement of women in STEM-based careers through to leadership positions. Under this funding program, three main initiatives are supported:



*Promoting and improving gender equality.*

**Science in Australia Gender Equity (SAGE)** is national program conducted by the Academy of Science and the Academy of Technology and Engineering to promote gender equity and gender diversity in science, technology, engineering, mathematics and medicine (STEMM).

- supporting the expansion of the SAGE program to include more Australian universities, research institutions and publicly funded organisations with a focus in STEMM;
- establishing a new group of Male Champions of Change focused on STEM-based and entrepreneurial industries, which is underway. The Male Champions of Change use their individual and collective leadership to elevate gender equality as an issue of national and international social and economic importance; and
- partnering with the private sector, community groups and educational organisations to foster interest in STEM and entrepreneurship amongst women and girls and celebrate female role models in STEM through a new \$8 million grant program.

In December, \$3.9 million was allocated to 24 projects that aim to remove barriers stopping women taking part in STEM education and careers.

## NATIONAL FUNDING AGENCIES

The Australian Research Council (ARC) and the National Health and Medical Research Council (NHMRC) have implemented a range of initiatives to support women researchers in STEMM within their granting schemes.

Both agencies have incorporated mechanisms to support researchers who have experienced a break in their career. These allow a researcher's experience and achievement, relative to their opportunity and participation in the research workforce, to be taken into account during grant assessment to help mitigate the effects of career interruption.

The ARC has extended the eligibility for its early and mid-career researcher fellowship schemes for researchers with career interruptions as result of maternity leave and caring responsibilities. The ARC also provides two named Australian Laureate Fellowships targeted at outstanding senior women researchers with additional funding for an ambassadorial and mentoring role to

promote women in research.

The NHMRC – since 2011 – has awarded the Elizabeth Blackburn Fellowships annually to the highest-ranked, funded woman applicant in its Research Fellowships scheme recognising outstanding women researchers in each of the biomedical, clinical and public health pillars.

The NHMRC is also reviewing institutional gender practices across the sector to highlight good practice and draw attention to areas that could be improved.

## GOVERNMENT INITIATIVES

The Women's Leadership and Development Strategy from the Office for Women, within the Department of Prime Minister and Cabinet, provides funding for initiatives that improve gender equality and provide support for women's economic empowerment and opportunity, safety, as well as promoting greater representation of Australian women in leadership and decision making roles.

The Office also provides scholarships through Chief Executive Women for senior executive women working in STEM industries to attend prestigious leadership programs.

The Public Service (APS) gender equality strategy is another central piece in Government initiatives to drive and sustain gender equality nationally.

"A clear goal of 50 per cent women for appointees to government boards is important," said Prime Minister Malcolm Turnbull. "We won't always reach it, but that should clearly be the target. Gender equality is an important, a critical objective in the APS."

While not specific to STEM, its reach extends to STEM policy and practice areas across the public service – including workforce, services and likely policy programs.

Increasing interest in gender equity issues in science is also inspiring bilateral and multilateral action in the region – for example the recent Women in STEMM workshop in India as part of the Australia-India Strategic Research Fund.

## PEOPLE INVOLVEMENT

NISA's funding program for Women in STEM and Entrepreneurship supports the greater participation of girls and women in STEM industries and encourages greater entrepreneurship.

In the first funding round a range of projects were supported including:

- Melbourne-based 'Girl Geek Academy' – the project will focus on girls aged 5 to 8 years with one-day events, online training and ongoing support aligned with the National Digital Technologies Curriculum, increasing early awareness and participation in STEM and entrepreneurship education;
- Geelong Manufacturing Council – the project will develop careers for women from the Geelong area in manufacturing and engineering through presentations, workshops, networking and mentor training as part of transitioning the region's industrial base from fabrication to advanced manufacturing;
- Science Technology Australia – the project 'Superstars of STEM', will support 30 women currently employed in STEM sectors to become highly visible public role models, to encourage girls and young women's interest in STEM careers;
- James Cook University – the 'She Flies Drone Camps: Building Northern Australia's Drone Ecosystem' project will focus on developing a series of camps aimed at teaching high school girls and their teachers or parents the possibilities of working with and flying drones from design and coding through to flying and finally using photography to create maps; and
- ATSE – will produce a series of up to 20 video profiles utilising female role models in STEM industries to be integrated into the Science and Technology Education Leveraging Relevance (STELR) program but with a focus to develop girls taking up STEM fields.

Other examples that can be emulated in STEM sectors is the recent simple, but powerful, action from Foreign Affairs Minister Julie Bishop where eight rooms at the Department of Foreign Affairs headquarters – which had been named after flowers and native plants – were renamed in honour of women who had helped break down barriers on behalf of the nation.

## THE WGEA

The Workplace Gender Equality Agency (WGEA), an Australian Government statutory agency created by the *Workplace Gender Equality Act 2012*, aims to promote and improve gender equality in Australian workplaces by providing advice, practical tools and education – and collecting and publishing data on the nation's performance

in gender equality.

The release of the 2016 WGEA national scorecard, a marker of equality trends within non-government organisations with more than 100 employees, demonstrated that while some improvement in key gender equality indicators has occurred over the past two years in Australia, there still continues to be significant gender inequality issues and that accomplished improvements, while important, are happening too slowly to have any meaningful impact.

But while change is slow, the results from the WGEA scorecard signal the importance of metrics and inform continued focus on areas of need, while celebrating improvements.

The need for meaningful and significant impact in the fields of STEM in Australia is critical, especially as we move into a more technology-based and innovative future.

We are at an opportune time where three critical factors of change coalesce:

- national commitment to STEMM sectors;
- collective mobilisation of the STEMM sectors; and
- the requisite tools and evidence base to drive transformation.

SAGE-Athena SWAN has the potential to be the Toyota Way\* for gender equality and diversity in STEMM in higher education and research, where leaders become accountable to demonstrate change. ☺

*\* The Toyota Way is a set of 14 principles and behaviours that underlie the Toyota Motor Corporation's managerial approach and production system and have won world attention as a management philosophy.*

*Dr Wafa El-Adhami is the Executive Director of Science in Australia Gender Equity (SAGE). With a research background in molecular biology and microbiology, she has held a number of senior management positions in the Australian Government, including with the Department of Health and Ageing, the Office of Chemical Safety and the Occupational Health and Safety Commission. More recently she has worked internationally as a consultant specialising in health policy, regulation and clinical solutions.*

*Before becoming SAGE Director of Science, Dr Saraid Billiards was the Director of Research Grants at the National Health and Medical Research Council (NHMRC), responsible for managing and delivering several funding schemes with an annual budget of approximately \$500 million. She was also responsible for NHMRC's Women in Health Science Committee – established to identify barriers and enablers to the progression and retention of women in health and medical research. She has a PhD in neurophysiology from Monash University.*



Helen Watt (right) with Celia Vandestad.

PHOTO: EAMON GALLAGHER

# Childhood clues to career esteem

**WOMEN IN THE DRIVING SEAT** Much of the world moves forward on STEM subjects – science, technology, engineering and mathematics – so why do brilliant young women shy away from STEM careers?

**C**elia Vandestad isn't your stereotypical research scientist. She's young, female and wears a bright-red lab coat. The 28-year-old PhD student is passionate about her research career in the Australian Regenerative Medicine Institute at Monash University, but it wasn't the path she mapped out at school.

When selecting her senior subjects, Ms Vandestad was faced with self-doubt. Maths and science – stress-free choices in her younger years – suddenly seemed daunting.

"I was scared of not doing well, as the subjects got harder," she recalls. "I was afraid of failing."

So she chose biology, a prerequisite for

her preferred undergraduate degree, but opted out of advanced mathematics.

It's a challenge Professor Helen Watt, from the Faculty of Education at Monash University, has seen young women face throughout her two decades of researching why students do or don't study science, technology, engineering and maths (STEM) subjects.

*Figures from the US show that the five per cent of the workforce who work in STEM contribute 50 per cent of sustainable economic growth. STEM fuels the critical engines of innovation and growth. Just 0.5 per cent of Australian university graduates are in mathematics and science – half the OECD average.*

Professor Watt is analysing the data from a study (2012–16) involving 1172 students from nine Catholic, independent and government-run, co-educational and single-sex schools in Melbourne and Sydney.

These studies paint a picture of what students think and feel as they make educational and career decisions to follow the STEM pipeline. It turns out that students'

– PROFESSOR HELEN WATT

## CULTURAL INFLUENCES

The gender imbalance in STEM careers is a global phenomenon with distinct cultural delineations.

Every few years the Organisation for Economic Co-operation and Development (OECD) tests students in 65 developed countries and, in a representative sample of 15-year-olds, girls generally outperform boys in science. This doesn't translate into career choices in Western societies such as the US, the UK and Canada, but it does in regions such as Russia, Asia and the Middle East, where more women than men take up science and maths careers.

US researchers believe the 'stereotype threat' in terms of gender roles in occupations originates in early childhood, suggesting clear cultural influences.

interests and perception of their own ability are the biggest drivers when deciding whether to opt in or out of STEM disciplines, and there also seems to be a glass ceiling above STEM careers.

Professor Watt's studies show that girls consider maths to be more difficult than boys do, and believe they're less capable, despite there being no gender difference in actual ability. Australian Council for Educational Research figures show that girls are more likely instead to opt for senior subjects in arts or humanities.

Boys, however, don't lack this self-confidence. They're drawn to advanced mathematics and physical sciences – especially if they have higher socio-economic status – or technical and computer sciences.

"This trend translates to university and career," Professor Watt says. "Boys follow pathways to higher-paying, higher-prestige jobs in mathematics and science, while girls choose careers they believe will make a social contribution."

Ms Vandestadt can relate – she chose myotherapy (a health discipline focused on relieving musculoskeletal pain) as her

undergraduate degree as a fast-track to helping people.

But does it really matter how gender and STEM interact?

Professor Watt doesn't hesitate to answer that it does: "From a social perspective, it is wasted talent. Women are just as capable in STEM as males, and they certainly don't prefer lower-salary or lower-status careers. They choose lower STEM careers because they believe they're not capable, are less interested, or because they perceive STEM workplaces as not being family-friendly."

This brain drain translates to a shortage of teachers coming through the STEM education pipeline, with 40 to 45 per cent of Year 7 to 10 maths and science teachers in Australia teaching outside their field.

## CAREER OF CHOICE

Could the solution be to make maths and science compulsory throughout school?

Professor Watt doesn't believe so. "In the US, senior high school mathematics is compulsory for university attendance regardless of discipline. However, forcing students to study these subjects at school isn't

translating into more STEM degrees or careers."

She says the real question should be how to demonstrate that maths and science can be useful in the careers to which girls are attracted.

One catalyst for change could be as simple as tweaking school timetables: "Schools tend to partition disciplines, and often maths and science clash with humanities on school timetables, which essentially forces students to choose one distinct path. Faced with this, girls can turn away from maths and sciences."

Pop culture could even play a role. Professor Watt would love to see a STEM version of the legal TV dramas credited for a surge in law careers.

She says it's also important to engage students from a young age, as self-concepts about ability are formed from as early as Year 2, and to create 'mastery' learning environments that focus on supporting students, as opposed to competitive, performance-based environments.

While Ms Vandestadt's love of learning eventually drew her to research as the ultimate quest for knowledge, she has some stern words for her high-school self: "Don't be afraid to be challenged, and study maths – it would have come in handy for all the programming and statistics involved in my research now."

Ms Vandestadt is now working on an initiative with other PhD students, drawing on support from Westpac and guidance from Professor Watt, to improve STEM awareness and education among young children and their parents. ☺

*• This article, written by Rebecca Jennings, first appeared in Monash University's Monash: Delivering Impact magazine.*

## WGEA NAMES 106 ACHIEVERS

The Workplace Gender Equality Agency (WGEA) has announced that 106 organisations are 2016 WGEA Employer of Choice for Gender Equality (EOCGE) citation holders. This is an increase from 90 last year and 76 in 2014.

WGEA Director Ms Libby Lyons said the growing list indicated that the business benefits and competitive advantage gained by addressing gender equality in the workplace were becoming more widely recognised.

The 2016 EOCGE citation holders range from small professional services firms to very large organisations including universities and banks, with male-dominated, female-dominated and mixed

industries represented.

"It is encouraging to see some new citation holders this year in diverse fields including transport, engineering, manufacturing, insurance and law," said Ms Lyons.

"Each industry has its own gender equality challenges. We hope all EOCGE citation holders can drive change in their own organisations as well as playing a leadership role to promote gender equality across their industries."

The list of 2016 EOCGE citation holders is on the WGEA website ([www.wgea.gov.au](http://www.wgea.gov.au))

# ATSE IN ACTION

## Climate Policy Toolkit targets emission cuts

Dr Wendy Craik FTSE, Chair of the Climate Change Authority (CCA), described the Authority's approach to climate change challenges at an ATSE NSW luncheon in Sydney in November – the last in a series of focused lunch meetings for 2016.

She referenced the CCA's Climate Policy Toolkit is discussing how Australia could best achieve the emissions reductions needed to meet the Paris 2030 climate target and the pathway to deeper emission cuts in the longer term.

The CCA's Climate Policy Toolkit was a



Richard Sheldrake and Wendy Craik

coordinated set of existing and new policies to capture emissions reduction opportunities in different sectors, Dr Craik said – and explained how these policies could be scaled up to achieve both the Paris 2030 target and longer-term targets.

She said the toolkit built on existing measures but incorporated new policies scalable to modify future targets as Australia compared its efforts with that of other countries, particularly its trade competitors.

Dr Craik described the opportunities for emissions reductions across various sectors including industrial, transport, land use and agriculture, electricity generation, energy efficiency and innovation.

Dr Craik's talk rounded off the NSW Division's 2016 luncheon series 'Climate Change and its Consequences', which has included previous talks by Gordon de Brouwer (Secretary Department of the Environment) on the implications of the Paris agreement (*Focus* 196), Chief Scientist Alan Finkel AO FAA FTSE speaking on the transition to a zero-emissions world (*Focus* 197) and CSIRO chair David Thodey AO FTSE speaking on the role of science and innovation in adapting to the changing climate.

## HUNTING FOR CLIMATE CLUES IN HOBART

Nearly 80 people attended a public lecture in Hobart in November to hear Dr Stephen Rintoul FAA from CSIRO deliver a thought-provoking address titled 'Hunting for Climate Clues in the Southern Ocean'.

Dr Rintoul is a physical oceanographer with a long-standing interest in the Southern Ocean and its role in the earth system. His research has contributed to a deeper appreciation of the influence of the Southern Ocean on regional and global climate, biogeochemical cycles and biological productivity. He was awarded an Antarctic Medal in 2012.

The event was organised by the Tasmanian Division in partnership with the Royal Society of Tasmania at the University of Tasmania.

It was followed by a dinner where the Board of ATSE met Tasmanian Fellows ahead of an ATSE Board meeting in Hobart the following day.



Steve Rintoul

## FORUM SEMINARS LOOK AT KEY ISSUES

Both the Minerals Resources Forum and the Health Technology Forum held seminars in Melbourne preceding the ATSE Annual General Meeting in November.

Minerals Resources Forum Deputy Chair Dr Paul Zulli launched its new Action Statement *Improving Productivity in the Mineral Resources Sector* to start the seminar.

The audience then heard from Mr Ric Gros (CEO, METS Ignited), Mr Mike Spreadborough (a senior mining executive) and Dr Craig Mudge FTSE (Research Fellow, CSIRO Mineral Resources), who each discussed the challenges facing the sector and showcased efforts to drive productivity improvements.

Mr Gros discussed the efforts of METS Ignited to drive improved collaboration between mining equipment, technology and service (METS) companies, mining companies and researchers through their Living Labs initiative.

Mr Spreadborough focused on the importance of embracing innovation at all levels of an organisation. Dr Mudge shared his experiences applying big data and machine learning to improve productivity on real-world mine sites.

Forum Chair Ms Denise Goldsworthy FTSE joined the speakers for a thought-provoking Q&A session and panel discussion.

The Health Technology Forum's topic was 'Personalised Healthcare: The Patient Will See You Now'. Professor Karen Reynolds FTSE, Forum Chair, discussed the major transformation in Australia's healthcare system

Speakers included: Mr David Roberts, Asia-Pacific Health Leader from Ernst & Young; Professor Ingrid Winship, Executive Director of Research from Melbourne Health; and Mr Andrew Saunders, Health Chief Information Officer from the Victorian Department of Health and Human Services.

Mr Roberts spoke about how the growth of digital technology is driving consumer-centric self-care.

Professor Winship gave a clinical perspective and discussed the role of genomics in personalised healthcare and Mr Saunders outlined the challenges and critical elements for government to develop effective person-centred digital health strategies.

These talks were followed by a lively panel discussion about the major opportunities and challenges participatory and personalised health bring for consumers, industry and government.

# ATSE IN ACTION

## Not whether, but how – and how quickly

### 2016 ATSE Oration

Gender equality at all levels of the workplace is now well understood to be a strategic and business advantage, ATSE's 2016 Orator Ms Elizabeth Broderick AO told the capacity audience at the Academy's Oration Dinner in Melbourne.

"The business case has been well argued in report after report and we have a global commitment at the UN and beyond to gender equality as a basic human right," she said.

But, as a nation, Australia's capacity for innovation and creativity is suffering because we are leaving out half our population, she said.

"Gender equality is now not a case of whether, but a question of how and how quickly!"

Ms Broderick is the former Australian Sex Discrimination Commissioner (2007–15) and Age Discrimination Commissioner (2007–11). She now chairs the Expert Advisory Group of the Science in Australia Gender Equity (SAGE) Initiative, in which ATSE is partnering with the Academy of Science, that will champion the SAGE initiative and provide expert strategic and gender equity advice to ensure a successful implementation and evaluation of the SAGE Pilot program.

Focusing on gender equality and STEM, she noted that Australia was "losing women and girls at every stage of the STEM pipeline, despite all the research telling us that there are no innate cognitive gender differences".

In universities women make up just 16 per cent of those with STEM qualifications, despite comprising more than half the population.

"When we break STEM areas down, Australia is positioned well below the OECD average in engineering, science and maths. It is particularly worrying that women's



Elizabeth Broderick delivers the 2016 Oration.

enrolments have actually decreased in computing over time.

### OCCUPATIONAL SEGREGATION

"Women in STEM employment are not making it to the top. We have an occupational segregation problem.

"STEM-qualified women are over-represented in clerical and administrative positions and under-represented in management. There is a gender pay gap – a tiny 12 per cent of women in STEM are high income earners (over \$104,000) compared to 32 per cent of men.

She posed the question: "What is at stake if we don't include diverse talent?" The answer – "Economies that thrive".

Ms Broderick told her audience that one thing she consistently found as Sex Discrimination Commissioner – and since – was that 'If you don't actively and intentionally *include* women, the system will unintentionally *exclude* them'.

"In the past, accelerating the careers of women in science has meant 'fixing' the women so they look more like men. It has been primarily a 'struggle for women, by women' and women's efforts have been, and continue to be,

largely responsible for progress.

"Responsibility for progress cannot sit on the shoulders of women alone. In science – just like every other sector – men hold power, they represent the system and therefore they are a critical part of the solution. So to all the men in the room, this is a call to action."

She instanced the Male Champions of Change (MCC) strategy, in which she took a lead establishment role, as a contributive initiative, operating under four guiding principles.

- 1 We step up beside women.
- 2 We prioritise the issue.
- 3 We stand behind our numbers.
- 4 We fix the system (not the women).

"The MCC's approach is to listen, learn and then lead through action. Leaders listen widely – hearing from gender experts and their own employees – particularly women. They prioritise making change through practical actions. They measure and report on progress and focus on shifting the systems that get in the way (not on 'fixing women').

"The MCC operating model involves small peer groups that work together. Members are carefully selected based on their ability to influence and impact change. Meetings occur quarterly and the discussions are serious, they are led by men, and action is taken.

The groups believed in a collective approach – that 'no one of us will ever be as good as all of us acting together', she said.

### DELIVERING IMPACT

Over the past five years, since its establishment, the MCC strategy had delivered impact in three main ways, Ms Broderick said.

"First, it has successfully continued to

*'If you don't actively and intentionally include women, the system will unintentionally exclude them.'*

– ELIZABETH BRODERICK

# ATSE IN ACTION

engage powerful men to tackle gender inequality. The coalition has grown from a single group of eight Australian private sector leaders, to over 100 CEOs, government department heads, Board Directors, VCs and CEOs of research institutes.

"Second, the MCCs' advocacy agenda has helped to shape Australia's national discussion on gender equality. The national conversation and media coverage of gender equality has shifted. Action has become a core expectation of Australia's senior leaders.

"Finally, and most importantly, the MCC strategy has resulted in tangible disruptive action. More than 15 innovative initiatives have been implemented across MCC organisations – including mainstreaming flexible work practices, taking the Panel Pledge, new standards on reporting and recognising

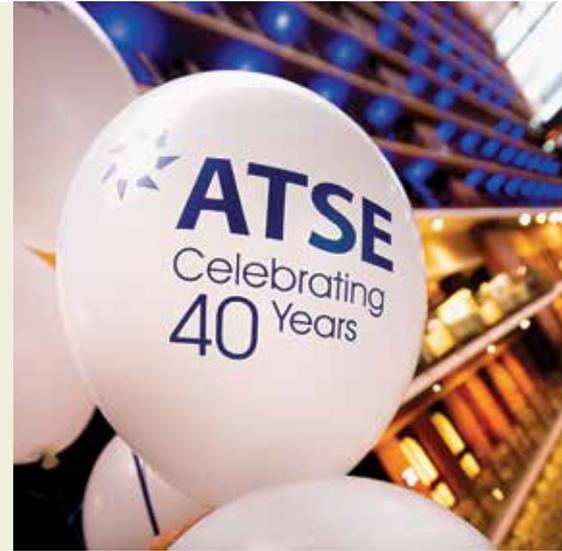
domestic violence as a workplace issue."

She highlighted the establishment of MCC STEM, a new initiative with the support of the National Innovation and Science Agenda planned to accelerate gender equality within the STEM fields.

"The group is a high-calibre and influential group of men that are collectively responsible for over half a million employees and billions of dollars of annual spend. We have the Chief Scientist, the CEOs of major technological and engineering businesses, research organisations such as CSIRO and ANSTO, and even the Royal Australasian College of Surgeons. Many of our members are ATSE Fellows," Ms Broderick said.

"There is no doubt that we are at an exciting moment for gender equality and STEM.

"At the national and global level there is



Marking ATSE's 40 years.

so much commitment to create change and who best to lead on this effort but the best of Australia's scientific minds?" she asked.

The business case and human rights imperative gender equality in STEM were compelling, she said.

"Indeed, our very future depends on it."

## ORATION DINNER HONOURS NEW FELLOWS

ATSE President Professor Hugh Bradlow FTSE presented Fellowship certificates at the Oration Dinner in Melbourne in November to most of the 26 New Fellows the Academy elected for 2016.

They were formally announced at the Annual General Meeting earlier that day and, again, most were able to participate in the New Fellows Seminar following the AGM.

The 2016 Fellows come from a wide array of sectors and specialisations, including agriculture, bionic vision, biotechnology, cyber security, defence, engineering, geotechnics, ICT, manufacturing,

medical research, neurosurgery, photovoltaics, resources, robotics, shipbuilding, structural dynamics and water management.

Each presentation at the New Fellows Seminar was recorded and are available on the ATSE YouTube site.

Academy Vice President and Membership Committee Chair Dr David Cook FTSE assisted the President in welcoming the new Fellows to the Academy.

The 2016 Oration Dinner attracted 190 people. To mark ATSE's 40 years, Foundation Fellows were acknowledged, as were ATSE's nine Presidents.



Professor Ian Reid receives his Fellowship certificate.



Dr Jackie Fairley receives her certificate from ATSE President Professor Hugh Bradlow.

# ATSE IN ACTION

## Newcastle engineer wins Batterham Medal

ARC Future Fellow Andrew Fleming has won the 2016 Batterham Medal, an award that recognises an early career engineer who has achieved substantial peer and industry recognition in the past five years.

The medal was presented to Associate Professor Fleming by Professor Robin Batterham AO FEng FAA FTSE at the ATSE Oration Dinner in Melbourne in November.

He is Associate Professor of Electrical Engineering at the University of Newcastle, where he graduated with a PhD in 2004. He has made an outstanding contribution to the science and engineering of nanoscale imaging and fabrication systems.

A highly regarded consultant in nanoscale imaging, fabrication and piezoelectric systems, the results of his work are found in consumer, industrial and scientific devices including mass storage, precision fabrication machines and scanning atomic force microscopes.

A recognised expert in the modelling, control and engineering of ultra-high-precision imaging and fabrication systems, Associate Professor Fleming (38) has consulted on some of the world's most



*Robin Batterham congratulates Andrew Fleming.*

ambitious scientific and industrial projects for NASA, The National Accelerator Laboratory, The Lawrence Berkeley Laboratory, Boeing, Stanford University, Nikon Research (all in the US), and the Defence Science and Technology Group in Australia.

Academically, he has received 30 competitive grants totalling more than \$10.6 million, including three Australian Research Council (ARC) Fellowships which span 12

years from 2006 until 2018. He established the Precision Mechatronics Laboratory at the University of Newcastle – a unique facility for the development of scanning probe imaging and fabrication systems, biomedical devices, and miniature robotics.

Currently, he is constructing a new facility for Raman near-field microscopy, which provides both nanoscale topographic mapping and chemical composition.

## ATSE BACKS NRI ROADMAP DRAFT

The Academy supports the nine infrastructure capability focus areas identified in the draft National Research Infrastructure Roadmap, but suggests that two additional areas be considered.

First, there is an urgent, ongoing and likely expanding need to better understand the construction and operation of civil infrastructure in Australia, including transport, energy, water and communications infrastructure, ATSE says in its submission responding to the draft Roadmap.

This critical infrastructure provides an enabling role for most other forms of economic activity (including the innovation ecosystem itself), and is essential to the future growth and prosperity of the nation.

“It is vital that Australia maintains the capability to conduct research on this civil infrastructure,” ATSE says.

Second, the Australian innovation sector needs to support large-scale demonstration and validation of novel industry-ready technologies, particularly relating to engineering science.

“This capability applies across a number of research and technology disciplines, but particularly in the energy and resources sectors, where the scale of capital required makes extensive validation

of new technologies critical,” ATSE says.

Given the current and future importance of energy and resources to the Australian economy (as recognised via the Industry Growth Centres priority areas and the National Science and Research Priorities), and the need to improve industry-research engagement, research infrastructure capabilities to support this validation and help encourage technology transfer and the domestic development of Australian research and technologies are vital.

ATSE says it is pleased to see that many of recommendations and suggestions from its initial submission to the Issues Paper have been adopted in the draft Roadmap, and welcomed the extensive and inclusive consultation process that led to the development of the draft.

The Academy congratulated the Expert Working Group for producing a “thorough and principles-based, transparent and comprehensive” draft.

The EWG is chaired by Australia's Chief Scientist Dr Alan Finkel AO FAA FTSE and includes Fellows Professor Edwina Cornish AO FTSE, Dr Andrew Cuthbertson FTSE and Dr Adi Paterson FTSE.

# ATSE IN ACTION

## Research engagement trial to start this year

This will be the first facility of its kind in Australia and will significantly advance the national research capability in the sciences, engineering and medicine.

On the industrial front, Associate Professor Fleming has filed six patent applications resulting in licencing in 13 countries. This technology has contributed to high-resolution imaging machines, semiconductor equipment and mass-storage systems.

He has also consulted to national and international companies, government organisations, and research institutes. This consultancy has included the local manufacture and delivery of electronics and control systems to organisations such as NASA, Newport Optics and Brookhaven National Labs (all in the US), and Queensgate Instruments in the UK.

### THE BATTERHAM MEDAL

In addition to recognising outstanding achievement in the application of engineering, the Batterham Medal aims to promote the profession of engineering, by promoting the contribution engineering makes to Australia.

It recognises the contribution to engineering made by Professor Robin Batterham, the Kernot Professor of Engineering at the University of Melbourne, and former Chief Scientist of Australia and Academy President.

The Award is presented annually by ATSE on behalf of the Go8 Deans of Engineering and Associates (the Group of Eight plus the universities of Newcastle, Wollongong and Auckland). It comprises the Batterham Medal and a cash prize of \$5000.

The 2016 judges were Mr Richard Kell AM FTSE (Chair), Professor Elanor Huntington, Ms Denise Goldsworthy FTSE, Air Vice Marshal (Retd) Julie Hammer AM CSC FTSE, Emeritus Professor Robin King FTSE, Mr Clive Weeks AO FTSE and Professor Karen Reynolds FTSE.

The Federal Government will pilot ways to measure the impact of university research and the engagement of research with business and industry in 2017.

It has opened applications for institutions to take part ahead of a national rollout of the assessment system in 2018. Participating universities are expected to make their pilot submissions to the Australian Research Council in May 2017. A review of the pilot will be reported in late 2017.

The trial follows the ATSE initiative to have an engagement metric built into the assessment of research in publicly funded research organisations (PFROs).

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

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

The Minister for Education and Training, Simon Birmingham, said the pilot was the next step in the National Innovation and Science Agenda to ensure that taxpayer funds were being targeted at research and initiatives that would ultimately pay dividends for Australians.

Mr Birmingham said the Engagement and Impact Assessment pilot would test the robustness of a wide range of indicators and methods of assessment for both research engagement and impact. It would include both quantitative and qualitative information, and involve universities, industry and other

end-users of research.

"The Engagement and Impact Assessment is about incentivising the smart and talented people working in our labs and universities to better focus on research that has wider economic and social benefits," Minister Birmingham said.

"We're also conscious of keeping the burden of too much reporting and paperwork to a minimum for universities who take part in the pilot and so the testing in 2017 will sample across different disciplines of research."

For 'engagement', the disciplines that will be tested by the pilot include chemical sciences, medical and health sciences, history and archaeology, and philosophy and religious studies. For 'impact' the disciplines

will include environmental sciences, agricultural and veterinary sciences, engineering, education, studies in creative arts and writing, and language communication and culture.

"We will review the pilot – including analysing the engagement and impact assessment methodologies and incorporating feedback from

university, industry and end-user participants – to inform the development of the full assessment," Minister Birmingham said.

Australia's universities have welcomed the announcement.

"Universities have worked closely with industry and Government on this important and very complex project. Many will take part in the voluntary, year-long pilot," said Universities Australia Chief Executive Belinda Robinson.

"We understand that the pilot – to be run by the ARC – is designed to road-test new arrangements to collect data about the impact and engagement of Australian research.

"We're all working towards a system that will give us an even clearer picture of the vast benefits to the nation derived from great Australian research.

"We look forward to seeing the first year pilot swing into action and to seeing the results," Ms Robinson said.

**"We're all working towards a system that will give us an even clearer picture of the vast benefits to the nation derived from great Australian research."**

# ATSE IN ACTION

## Industry–research collaboration through a Defence prism

Innovation in the defence industry was the theme of the latest of ATSE's series of collaboration forums held in Sydney.

It was the third in a series of forums (previously held in Melbourne and Brisbane), organised by the Academy's Innovation and Industry Forum combined with the NSW Division, titled *Greater Collaboration – The Industry Challenge* and moderated by Professor Ron Johnston FTSE of the Australian Centre for Innovation.

Defence industry leaders Mr Chris Jenkins, CEO of Thales Australia and New Zealand, and Mr William Hutchinson, Chairman of Thomas Global Systems, described their respective experiences of how innovation aimed at company competitiveness is being addressed in the modern defence company.

They spoke against a background of Australia ranking at the bottom of OECD statistics on the level of collaboration between companies and research institutions and Ms Kathryn Fagg FTSE, Innovation and Industry Forum Chair, stressing that Australia needs to find a new approach, involving collaboration, with businesses investing in innovation to drive their productivity growth.

Mr Jenkins emphasised the 'smart buyer' value chain as a key means of sustaining company capability to deliver mobility and protection to an ever-evolving defence force. He said Thales in Australia has moved from conducting 80 per cent of its own innovation internally a decade ago, to 80 per cent outsourced locally for the Hawkei protected mobility vehicle today.

The company's partners in the innovation journey form a holistic supply chain enterprise bringing essential niche expertise and know-how to the table, he said.



Kathryn Fagg addresses the forum in Sydney.

Thales had close links with a number of universities and defence research agencies, which provided blast modelling expertise as the Bushmaster vehicle design was optimised for its life saving protection and rapid transport capability for military personnel.

He said Thales would spend sizeable resources over the next three years to create product capability suitable for export. Effective collaboration was all-important and company staff and external partners were now selected on their collaborative behaviours.

Mr Hutchinson described how Thomas Global Systems had evolved over the six decades from supplying componentry to television manufacturers in the 1960s to the aviation and defence display systems it is known for today.

The company's innovation chain relied heavily on senior staff bringing in knowledge and networks as needs changed, he said.

While there were few links with local universities, except for graduates and interns, Mr Hutchinson quoted the University of California Irvine as bringing a refreshing approach to innovation teaming – with both size and culture playing a role.

Themes emerging in discussion were the following.

- **Significant value is extractable from innovation in the supply chain**, where large companies with significant market power play a role in bringing SMEs with them. Young, fast-moving SMEs can assist large older and slower companies to enable both to stay competitive.
- **There are different models of collaboration in different industry sectors**. For example Sydney-based SME Clarity Pharmaceuticals Ltd gains significant leverage with the IP rights secured from ANSTO and universities, by outsourcing clinical trials of its technology to those best placed to undertake it.
- **Government has a role to play**. But while continuity of industry policy settings is important, support from government for export activity is well below that of key competitors in the defence industry in France, the UK and the US, whose governments promote company products as national innovations.
- **The recent movement in Australia to improve incentives for researchers and industry players to collaborate was welcomed**, particularly the new arrangements for research block grants designed to drive greater research industry engagement, and the Ferris Review recommendation for the introduction of a collaboration premium of up to 20 per cent on the R&D tax incentive.
- **One factor holding Australia back was thought to be the deeply conservative risk-averse culture of government departments**. In Australia, technology must be proven before government will procure it, whereas Singapore's purchasing policy serves to drive innovation.

ATSE President Professor Hugh Bradlow FTSE challenged those present to remember that while discussion had focused primarily on manufacturing and pharma, two-thirds of the Australian economy was driven by the services sector, which also required innovative collaboration to continue to prosper.

*In Australia, technology must be proven before government will procure it, whereas Singapore's purchasing policy serves to drive innovation.*

# ATSE IN ACTION



Participants 'see the light' at the Bandung STELR workshop.

## Taking STELR to Bandung

STELR recently ran five days of STEM workshops in Bandung, Indonesia, at the invitation of the South East Asian Ministers of Education Organisation (SEAMEO). The workshop was attended by more than 40 teachers, education officials and education academics from Indonesia, Malaysia, Singapore, Thailand, Brunei, Timor Leste and Laos.

Among the participants were teachers from three schools in Bontang, a town in East Kalimantan, which have each been provided with a class set of STELR Renewable Energy equipment by Orica, which has a manufacturing facility close by, and is a long-term sponsor of the STELR program.

As well as providing the STELR equipment, Orica also organised and sponsored the travel for the six teachers attending the training as part of their commitment to local host communities.

Workshops were presented by Peter Pentland, ATSE Executive Manager Education, Pennie Stoyles, STELR Program Manager, Dr Greg Smith from Charles Darwin University and Simone Lewis from Southern Cross University. Both Charles Darwin University and Southern Cross University are partners with ATSE in developing new STELR modules as a part of the iSME project.

Dr Smith has been working on the *Carbon Dioxide – friend or foe?* modules and Ms Lewis has been working on the *Water for the 21st Century* module.

Ms Kay Lembo, Manager of the Queensland STEM Education Network, attended as an observer and assisted with activities.

The STELR modules were used as the context for participants explore the principles of STEM education, inquiry-based learning, scientific literacy and science as a human endeavour. The relevant educational and environmental contexts for Southeast Asia were incorporated into the program.

ATSE is grateful to Orica Global Community Manager Ms Natalie Bain and the Orica Site Manager at Bontang, Mr Hartono Wijaya, who attended the opening and closing ceremonies respectively, and to the SEAMEO QITEP in Science for organising the workshop and assisting with translation of STELR resources into Indonesian.

The workshop was supported by the Australian Government through the Australia-Indonesia Institute of the Department of Foreign Affairs and Trade.

## EDUCATION FOR INNOVATION

**E**ducation for Innovation – Creativity, Professionalism and Diversity will be the topic of a one-day conference ATSE will hold in Sydney on 24 February.

Organised by ATSE's Education Forum, it will seek to identify ways to improve Australia's approach to science, technology, engineering and maths (STEM) higher education to enable the nation to meet national challenges and maintain global competitiveness.

Moderated discussion will seek to identify methods to facilitate Australia's improved performance and future success in these areas, including the pipeline from schools, by asking:

- 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 will include Professor Sarah Maddison, Dean, School of Science, Professor of Astrophysics, Swinburne University of Technology; Professor Attila Brungs, Vice-Chancellor and President of the University Technology Sydney; Dr Cathy Foley PSM FTSE, Deputy Director and Science Director of CSIRO Manufacturing; Professor Iven Mareels FTSE, Dean, Melbourne School of Engineering, University of Melbourne; Professor Mary-Anne Williams FTSE, Director of Disruptive Innovation, University of Technology Sydney; 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 of ATSE Gender Equity Working Group; and Professor Robert Wood, Deputy Vice Chancellor, University of Western Australia.

The event will be at the Aerial UTS Function Centre, University of Technology Sydney.



Professor Sarah Maddison

# ATSE IN ACTION

## STELR features in new school program

STELR renewable energy equipment was a key feature at the launch of a new Year 10 program at Patterson River Secondary College, on Melbourne's outskirts.

Under the program, Year 10 students will be given the opportunity to explore subjects including electricity systems, solar generation, battery storage, data collection and analysis.

As part of this initiative, the school library will also be upgraded to become an 'energy laboratory', where energy data measured by sensors can be studied by students.

Students will use data sources to make recommendations to the school to reduce energy wastage while attempting to maximise student comfort levels.

"Patterson River SC is pursuing the target of being an energy provider for both itself and members of the community in a manner that will allow students to coordinate elements of the business," said College Principal Daniel Dew.

Launching the program, the Victorian



Lily D'Ambrosio is 'all eyes' on the STELR equipment.

Minister for Energy, Environment and Climate Change, Lily D'Ambrosio, said: "This initiative will help to educate the next generation of energy professionals and create pathways for students into careers in renewable energy, energy efficiency and new energy technologies."

Earlier this year Patterson River SC purchased the STELR Renewable Energy materials to incorporate into the program by giving students strong grounding in the science behind both wind and solar energy.

## SOLAR CAR CHALLENGE A STELR KEY

Funding from the Australian Power Institute (API) enabled 10 new schools to join the the Solar Car Challenge program in 2016 as part of their STEM involvement through STELR.

The solar car activity is the culminating activity of the STELR Renewable Energy module, where students apply the knowledge they have gained from the STELR unit. Students test their cars against each other.

More than 200 schools have now received class sets of solar cars from API and in 2016 a total of 19 schools in five states (Tasmania, Queensland, NSW, South Australia and Victoria) participated in the Challenge.

API provides funding for the Solar Car Challenge as a part of its ongoing support for STELR, providing class sets of reusable model solar car kits for schools across Australia. Each class set makes 14 model solar cars each comprising a chassis, two sets of wheels, a motor, a gearbox and two solar panels. The kits are provided free of charge to schools.

API encourages involvement between university engineering students (who are currently a part of the bursary program) with participating high schools by sending each school a university student to deliver a presentation on careers in the renewable energy industry. During the visit the young undergraduate engineers also assist with solar car construction, judge the cars and frequently award the prizes.

## STELR SCHOOL WINS ENERGY AWARD

Huonville High School in Tasmania – a STELR school – won the Oceania region award in the Global High Schools category of the Zayed Future Energy Prize, announced in Abu Dhabi. The 465-student rural school will receive up to US\$100,000 to spend on a project.

Huonville became a STELR school in August 2014 and teachers Rob Ash and Nigel Baptist attended a PD training session in Hobart in December 2014.

Funding from the Zayed Future Energy Prize will be used to raise the renewable energy capacity of the school to 60 per cent, up from its current level of 2.5 per cent. The school also plans to develop a Zayed Energy Hub, which will function as a laboratory, run on 100 per cent renewable energy, and showcasing solar technology, battery storage, insulation models, pellet heating, LED lighting and data management.

The Zayed Future Energy Prize winners were announced during Abu Dhabi Sustainability Week. There were 1678 entries this year, and there have been a total of 10,000 submissions and nominations made over the nine years since it was inaugurated in 2008. Huonville was one of five schools worldwide chosen from a shortlist of 15. Winners in other categories were schools in Kenya (Africa region), Indonesia (Asia), Ireland (Europe) and Bolivia (Americas).

The Zayed Future Energy Prize honours the late President of the United Arab Emirates, Sheikh Zayed bin Sultan al Nahyan and celebrates achievements that reflect impact, innovation, long-term vision and leadership in renewable energy and sustainability. The primary aim of the Global High Schools category is to inspire future generations across the world to be responsible, sustainable citizens. The Prize hopes to encourage young people to learn about sustainability and clean energy from an early age.

# WOMEN IN TECHNOLOGY

## STELR gets \$250,000 to encourage girls into STEM



*The new face of engineering.*

ATSE's STELR program has been awarded a government grant of \$250,000 to produce a series of up to 20 video profiles using female role models in STEM industries to encourage girls to engage in STEM fields.

The grant was one of 24, totalling \$3.9 million, made to a variety of Australian organisations under Round 1 funding from the \$8 million Women in STEM and Entrepreneurship grant program under the National Innovation and Science Agenda.

The program aims to encourage girls and women to study and pursue careers in science, technology, engineering and maths (STEM).

Announcing the grants, the Prime Minister noted that only one in four IT graduates and fewer than one in 10 engineering graduates are women; that women occupied fewer than one in five senior researcher positions in Australian universities and research institutes; and were less than half the overall STEM workforce.

A wide range of projects will receive funding, from building interest in STEM for primary school age students, to supporting postgraduates and women already pursuing STEM careers, and encouraging entrepreneurship among women.

Apart from the STELR initiative, other projects funded include:

- Melbourne-based 'Girl Geek Academy' – focusing on girls aged 5 to 8 years with one-day events, online training and ongoing support aligned with

the National Digital Technologies Curriculum, increasing early awareness and participation in STEM and entrepreneurship education;

- Canberra-based CBR Innovation – for 10-week programs for girls in Canberra and the surrounding region that include skills workshops, career presentations, field trips and female STEM mentoring;
- Geelong Manufacturing Council – developing careers for women from the Geelong area in manufacturing and engineering through presentations, workshops, networking and mentor training as part of transitioning the region's industrial base from fabrication to advanced manufacturing; and
- Verco Engineering, from Clare, SA – to offer 11 workshops for up to 1000 Year 9 and 10 girls in regional SA built around applying STEM subjects and principles and new technologies to increasing productivity in rurally based jobs.

Other successful applicants included the Australian Institute of Nuclear Science and Engineering (AINSE); the Florey Institute; James Cook, Murdoch, RMIT, Adelaide, Southern Queensland, Sydney and Wollongong universities; the Royal Institution of Australia; and the Warren Centre.

Applications for a second round of the Women in STEM and Entrepreneurship program will open in 2017.

## WOMEN WIN MCA SCHOLARSHIPS

The Minerals Council of Australia (MCA) awarded three \$20,000 Australian Minerals Industry Research Scholarships in 2016 to facilitate research and training in areas of practical value to the Australian minerals industry and enhance the recipients' research experience with industry partners.

The inaugural recipients were:

- Hang Wang from the University of Adelaide for her PhD project 'Modelling of Natural Oxidation of Pyrites in Refractory Gold Ore Stockpiles to Improve Gold Recovery' (with industry partner Newcrest);
- Philippa Dodshon from UQ for her PhD project 'Critical Risk Control Management' (with industry partners Rio Tinto and Thiess); and
- Laura Petrella from UWA for her PhD project 'Controls and Genesis of Gold Mineralisation within the Dead Bullock Soak Mining Lease' (with industry partner Newmont).

MCA will be offering these scholarships again in 2017.

## STEPHANIE FAHEY HEADS AUSTRADE

Dr Stephanie Fahey, a former Deputy Vice Chancellor of Monash University, is the new CEO of the Australian Trade and Investment Commission (Austrade), replacing Mr Bruce Gosper who becomes High Commissioner to Singapore.

Dr Fahey will be the first woman to lead Austrade. She brings a wealth of international trade and investment experience and was Lead Partner for Education, Oceania at Ernst & Young before her Austrade role.

Dr Fahey has also led a research institute at the University of Sydney and is currently Chair of the NSW International Advisory Board, a Council member of the European Australian Business Council, a Board member of Canberra Institute of Technology, and a Board member of The Asia Foundation

(Global Board). She has served on a number of other bodies including the Foreign Affairs Council, the Australia Korea Foundation, and a subcommittee of the Prime Minister's Science, Engineering and Innovation Council.



*Stephanie Fahey*

# WOMEN IN TECHNOLOGY

## Preparing women for financial challenges

A new initiative in Western Australia is taking an unusual approach to supporting women to become more financially literate – by creating ‘Financial Toolbox’ workshops to enable them to achieve greater financial independence.

*A Financial Toolbox workshop in session.*



Former WA Chief Scientist Professor Lyn Beazley AO FTSE chairs a ‘Women in Leadership’ committee established under the auspices of the American Chamber of Commerce (AMCHAM) in WA, with Professor Mark Bush FTSE, former Division Chair, as Deputy Chair. The Committee aims to make a significant impact on the persistent problem of delayed progression of women in their careers or

permanent loss from the workforce altogether.

Key facts driving the initiative are.

- Homelessness among women, including women who have had professional careers, is on the increase. While more men than women were homeless at the time of the 2011 Census, nearly 60 per cent of those supported by homeless services

were women. Between 2011-12 and 2014-15 the number of women aged over 55 accessing homelessness services increased by 30 per cent.

- Women in WA have barely more than half the superannuation savings of men, and up to 60 per cent of WA women retire with zero superannuation.
- Women earn 25 per cent less than men on average, and many WA women still lack financial confidence and skills to invest.

The Committee noted a tendency to focus on supporting women who have already reached relatively senior levels in their careers, and that a range of initiatives at company, industry or government level currently exist.

But it identified a common theme – the path to senior leadership would have been far easier for these women had they known early in their careers the finance-related challenges to come and how to prepare for them. These included the impact of temporarily leaving full-time work to establish a family, the impact of potential life-partnership breakdown, and the nuances of superannuation, insurance and personal financial management.

Collaboration between AMCHAM, Chartered Accountants Australia and New Zealand and the Australian Institute of Company Directors has enabled the Committee to build a series of workshops for women, packaged as a ‘Financial Toolbox’ in two parts:

- Part 1 – Build Yourself Up: Budgeting and Forecasting; Saving with Superannuation; and Get to Know your Taxes.
- Part 2 – Protect Yourself: Personal Insurance; Wills and Estates; and Life Events.

The Part 1 workshops were delivered in the second half of 2016, to overwhelming acclaim. All workshops were heavily oversubscribed and will be repeated in 2017. Part 2 workshops will be delivered in the first half of 2017.

## NANCY MILLIS MEDAL GETS FUTURE FUNDING

The memory of one of ATSE’s most celebrated Fellows has been enhanced with the decision by the University of Melbourne to provide ongoing funding for the Nancy Millis Medal.

Awarded by the Academy of Science (AAS), the Nancy Millis Medal was established to honour the contributions made to science by the late Professor Nancy Millis AC MBE FAA FTSE and recognises her importance as a role model for women aspiring to be research leaders. It is awarded to women who have demonstrated exceptional leadership in the areas of STEM.

To announce its funding of the award, the university hosted an event in late 2016 to celebrate the impact the Nancy Millis Medal has had for women working in STEM disciplines.

AAS President Professor Andrew Holmes AC FRS FAA FTSE said what began with a small group of Professor Millis’ colleagues coming together to create an award to celebrate her work had now become one of the Academy’s most popular awards. “More than 100 remarkable women have already been nominated for the Medal in its short life span,” he said.

Deputy Vice Chancellor Professor Jim McCluskey said the university was proud to honour Professor Millis, who was a national figure, an alumna (studying at University of Melbourne in the 1940s) and a member of the Department of Microbiology (1952 to 1988). “Professor Millis was a wonderful scholar and a great character. The obvious traction the Medal, named her in honour, has for women in STEM would have made her both proud and humble.”

Provost Professor Margaret Sheil FTSE added: “While an icon for all Australian microbiologists, Professor Millis treated discrimination with disdain, saw integrity as a guiding principle and was quick to promote youthful endeavour. She led with distinction various national committees that dealt with key STEM issues like the emergence of molecular biology and its sensible governance. She would be delighted to think that a medal struck to recognise the accomplishments of female scientists was so actively pursued.”

*The 2017 Nancy Millis Medal for Women in Science will be awarded to Associate Professor Kerrie Ann Wilson, University of Queensland, who has made significant discoveries in the environmental sciences that have resulted in more effective conservation practices.*



*Nancy Millis celebrating her 90th birthday in 2012.*

# WOMEN IN TECHNOLOGY



## Tackle the hardest tasks, says Michelle Simmons

*Michelle Simmons on Australia Day.*

University of NSW quantum physicist Professor Michelle Simmons FAA FTSE has urged young people to tackle life's hardest tasks and to strive to be the best they can be.

Delivering the 2017 Australia Day address for NSW, Professor Simmons, the first female scientist to deliver the address in its 20-year history, said intellectual independence, innate optimism and willingness to "give it a go" made Australia the best country in the world to do research.

But the UK-born scientist, who is leading the world in the race to build a prototype quantum computer, warned that Australia's educators were jeopardising the future by lowering the expectations they set for students.

"Great teachers with high expectations challenge their students to be the best they can be," Professor Simmons said. "However, equally important are the curricula that they teach.

"One of the few things that horrified me when I arrived in Australia was to discover that several years ago the high school physics curriculum was 'feminised'. In other words, to make it more appealing to girls, our curricula designers in the bureaucracy substituted formulae with essays.

"From the students coming to university, I see little evidence that this has made any difference and indeed I see many students complaining that the physics curriculum has left them ill-equipped for university," she told an audience at the Sydney Conservatorium of Music.

"There is a big cost in this type of

thinking. When we reduce the quality of education that anyone receives, we reduce the expectations we have of them. If we want young people to be the best they can be (at anything) we must set the bar high and tell them we expect them to jump over it.

"My strong belief is that we need to be teaching all students – girls and boys – to have high expectations of themselves."

The director of the UNSW-based Australian Research Council Centre of Excellence for Quantum Computation and Communication Technology, Professor Simmons heads a team that is working to develop a prototype quantum computer in silicon. She is one of a handful of researchers in Australia to have twice received a Federation Fellowship and now a Laureate Fellowship, the Australian Research Council's most prestigious award.

She said her team currently enjoyed a two to three-year lead on other teams striving to build a quantum computer. But she said with billions of dollars of investment pouring into the field, "our next challenge is to see whether we benefit from our international lead and translate our research into high-technology industries here in Australia".

Professor Simmons also had a broader message for all Australians on Australia Day.

"In Australia, when praising ourselves ... we tend to emphasise the beauty of our natural environment, our great lifestyle and the easy-going nature of our people – 'The Lucky Country'.

"I think this is a mistake, because it doesn't acknowledge the hard work that people have done to be successful and it

encourages us to shy away from difficult challenges. In short, I believe it will eventually stop us from being as ambitious as we might be," Professor Simmons said.

"As we take things to the next phase of trying to build a prototype quantum computer, I feel proud to be a part of the team that is going to make this happen. I am grateful for that Australian spirit to give things a go, and our enduring sense of possibility. In this, we have so much to be thankful for – and, more importantly, so much to look forward to.

"But there is room for improvement as well. In our innovation policies, in our education system, and in the ambitions of our scientists and discoverers, I want Australians above all to be known as people who do the hard things."

*Professor Simmons was awarded the 2015 CSIRO Eureka Prize for Leadership in Science and in 2016 was awarded the Foresight Institute Feynman Prize in Nanotechnology.*

## FIONA SIMSON HEADS NFF

NSW mixed farmer and grazier Ms Fiona Simson has been elected President of the National Farmers' Federation (NFF) – the first female President of the NFF in its 37-year history.

Ms Simson, her husband Ed and family run a mixed farming enterprise including broadacre farming as well as breeding commercial poll Hereford cattle.

She has previously served the NFF as Vice President for two years and as a Director since 2011. She was also the first female President of NSW Farmers.

"It is an honour and privilege to represent Australian farmers at the national level and to be elected as the NFF's first female president. To me, it's a great acknowledgement that women contribute tremendously on-farm, along the value chain, and increasingly as thought leaders and public advocates for agriculture," Ms Simson said.



*Fiona Simson*

# NEWS

## BioClay a “game-changer” for crop protection

Researchers at the University of Surrey and University of Queensland have developed a revolutionary new crop-protection technique that claims to offer an environmentally friendly alternative to genetically modified crops and chemical pesticides.

The breakthrough research could have huge benefits for agriculture and positively impact communities around the world.

The researchers have found that by combining clay nanoparticles with designer ‘RNAs’ (molecules with essential roles in gene biology), it is possible to silence certain genes within plants. The spray they have developed – known as BioClay – has been shown to give plants virus protection for at least 20 days following a single application. When sprayed with BioClay, the plant ‘thinks’ it is being attacked by a disease or pest insect and responds by protecting itself.

The latest research overcomes the instability of ‘naked’ RNAs sprayed

on plants. Loading RNAs onto clay nanoparticles enables them to be released over an extended period of time before degrading.

The BioClay technology, which is based on nanoparticles used in the development of human drug treatments, has a number of advantages over existing chemical-based pesticides. Since BioClay is non-toxic and degradable, there is less risk to the environment and human health. It can also be used in a highly targeted way to protect crops against specific pathogens.

Professor Max Lu AO FTSE, Vice-Chancellor of the University of Surrey and co-author of the research paper, said: “This is one of the best examples of nanoparticles being effective for biological molecular delivery with a controlled release rate for combating diseases in plants or animals. The same nanoparticle technology invented and patented in my laboratory at the University of Queensland was used for effective targeted drug delivery. It was licensed to an Oxford-based pharmaceutical company and is now being commercialised for drug development.

Plant pests and pathogens are estimated to reduce global crop yields by 30 to 40 per cent a year, constraining global food security. At the same time, the need for higher production, regulatory demands, pesticide resistance and concern about global warming driving the spread of disease all mean there is a growing need for new approaches to crop protection.



Max Lu



The Centris americana bee in action. PHOTO: MARCELO CAVALCANTE

## POLLINATOR HABITAT NEEDS PROTECTING

Protecting habitat to promote pollinators, especially bees, should be used as a fundamental part of farming to secure and increase yield in pollinated crops, according to the first internationally coordinated review, published in *Nature*.

The research identified five major causes driving pollinator decline: changes in land use and intensity, climate change, pesticides, management of pathogens, and invasive alien species.

Strengthening pollinator-friendly practices in the diversified farming systems supported by many indigenous peoples and local communities globally was identified as a key response to changes in land use and intensity.

The review identified a range of solutions to threats facing the animals and how they could be better used to promote production of the world’s food sources that rely on pollination.

Globally, 1.4 billion jobs are dependent on pollinators, such as bees, and three-quarters of crops, worth \$500 billion annually, rely on animal pollination. Wild and managed pollinators – vertebrates such as bats and lizards and thousands of species of insects – provide a host of benefits to humans, ranging from contributions to industrial crop production to food security for rural communities through honey-hunting and beekeeping.

The 20,000 identified species of bees, in particular, pollinate more than 90 per cent of the world’s pollinator-dependent crops but, despite their importance, nine per cent of both bees and butterflies are threatened in Europe.

The report said intercropping, using crop rotations that include flowering crops, incorporating wild plants in home gardens, and customary rules that protect pollinator habitat could be expected to foster diverse pollinators.

## Bushfire predictions at your fingertips

Researchers at The University of Western Australia are developing a new touchscreen device that can be mounted in a fire truck to help firefighters predict where and when a bushfire will spread.

The researchers are modifying bushfire simulation software 'Australis' into a high-end tablet to provide accurate predictions of fire behaviour more rapidly than current methods.

The Australis system analyses data including geographical topography, vegetation types, WA bushfire-prone hotspots, time since last burn, rate of spread, fuel accumulation and forecasted weather.

In a matter of minutes, and without internet connectivity, it can accurately predict where the fire could be from 30 minutes to 24 hours into the future.

Professor George Milne from UWA's School of Computer Science and Software Engineering said the technology could protect lives, homes, crops and livestock in WA's bushfire-prone areas.

"Having the Australis fire prediction technology in the cab of a fire truck or a farmer's ute will enable first-responders to get the best information necessary to create appropriate firefighting and evacuation strategies," Professor Milne said.

Professor Milne said the touchscreen device would complement the 'Aurora' system used by the Department of Fire and Emergency Services (DFES), which currently runs the simulator from one central location for all fires in WA.



George Milne with the Australis bushfire-prediction software.

"On a day where there are several bushfires across the state, it may take too long to predict each individual fire's progress using a single system in the central headquarters," Professor Milne said.

"The advantage to local brigades with access to this technology is that it will give them location-specific information about which communities are at risk and which need to be evacuated."

WA was unique in the world, Professor Milne said – with bushfires burning every day of the year, from the north during the winter dry to the south in summer.

## NEW DATA TO IMPROVE FLOOD MODELLING

Flood modelling across Australia will be more accurate, following the first major upgrade of the Australian Rainfall and Runoff (ARR) Guidelines in three decades.

Geoscience Australia and Engineers Australia worked for over four years on the comprehensive upgrade, which is now complete and contains nearly 30 extra years of rainfall data from the Bureau of Meteorology.

Geoscience Australia's Chief Executive Officer Dr Chris Pigram FTSE said while the Guidelines had been revised a number of times since they were first published in 1958, there had not been a substantial update since 1987.

A review into a series of floods in the summer of 2010-11, including the January 2011 Brisbane floods, called for a complete upgrade to the Guidelines.

"With Engineers Australia, we've undertaken a complete revision of the Guidelines to ensure they are comprehensive with truly national



Chris Pigram



Andrew Johnson

coverage. "For the first time, the Guidelines are completely based on Australian data. They include data from more than 30 years of observations from across the continent, including at least 100,000 storm events."

Engineers and town planners use the ARR Guidelines to develop accurate and consistent flood studies and mapping across Australia; these are then used to design dams, stormwater drainage, improve floodplain management and assist land managers with soil conservation strategies.

Ownership of the ARR Guidelines recently transferred from Engineers Australia to Geoscience Australia, the Australian Government's national geography and geology agency.

The BoM's Chief Executive Officer Dr Andrew Johnson FTSE said the new estimates include observations from over 10,000 rainfall gauging stations, including 2300 extra rainfall stations with nearly three decades of extra rainfall data.

"We've also used statistical analysis techniques that weren't available 30 years ago."

# NEWS

## Mapping the future of manufacturing

CSIRO has released its Advanced Manufacturing Roadmap, written in collaboration with industry, government and researchers, which identifies major growth opportunities and what manufacturers need to do to achieve them.

The Advanced Manufacturing Roadmap is the first in a series of roadmaps being produced by CSIRO, each aligned to the Federal Government's Industry Growth Centres.

It calls on Australia's research and manufacturing sectors to increase their collaboration and alignment with each other and urges manufacturers to:

- place a greater focus on participation in global value chains;
- improve their ability to attract and retain staff with skills in digital literacy, leadership, customer interface and STEM capabilities;
- increase the gender, age and ethnic diversity of their workforce; and
- improve business-to-business collaboration.

It spells out how manufacturing is becoming increasingly global, with integration into international value chains vital.

"The Advanced Manufacturing Roadmap is the compass that guides our excellent science to deliver the breakthrough innovation needed to re-imagine Australian advanced manufacturing," said CSIRO Chief Executive Dr Larry Marshall FTSE.

"Australian science can turn disruptors and increased globalisation into opportunities for value creation right here at home."

Over the next 20 years, Australia's manufacturing industry must

evolve into a highly integrated, collaborative and export-focused environment that provides high-value solutions.

The sector needs to focus on pre-production activities such as design, research and development, as well as value-adding services, sustainable manufacturing and low-volume/high-margin customised products.

CSIRO Manufacturing Director Dr Keith McLean said the evolution of Australia's manufacturing industry would require significant technological innovation by public and private research communities.

"The industrial landscape is changing fast. We need to start evolving with it," Dr McLean said.



Printable solar cells are one opportunity for Australia's high-tech, research-driven manufacturing sector.



## AN AUSTRALIA DAY TO REMEMBER

Most high school students can expect excursions to the local science centre, zoo or museum, but how about a trip to a continent few will ever get to see?

Australia Day 2017 was one 'out of the box' for 18 high school students from Kent Street High School in Perth when they boarded a Qantas Boeing 747 aircraft and flew over the South Magnetic Pole.

The students were accompanied by their award winning teacher Ms Suzy Urbaniak, who received the Prime Minister's Prize for Excellence in Science Teaching in Secondary Schools last year, and PhD candidates from The University of Western Australia and the International Centre for Radio Astronomy Research (ICRAR).

"The science in my classroom is all about inquiry and investigation – giving the students the freedom to develop their own investigations," said Ms Urbaniak before the flight.

"From the windows of this flying classroom, my students will gain a unique understanding of the science responsible for the beauty and natural wonders of the seventh continent."

A student's-eye view of Antarctica.

PHOTO: JOHN MARMARAS



## Australia's solar thermal technology for China

Australia's solar heliostat technology will be used for concentrating solar thermal (CST) electricity generation in China under an arrangement between CSIRO and Chinese company Thermal Focus.

China has announced its intention to produce 1.4 GW of CST by 2018, and 5 GW by 2020, which would double the world's installed CST plants.

The CSIRO-Thermal Focus relationship enables Thermal Focus to manufacture, market, sell and install CSIRO's patented low-cost heliostats, field control software and design software in China, with

*CSIRO's solar thermal heliostat technology will help China deliver its clean energy targets.*

a shared revenue stream back to Australia to fund further climate-mitigation research.

CSIRO Chief Executive Dr Larry Marshall FTSE said he was proud of CSIRO Energy's solar thermal technology team and its innovative science for the contribution it was making to support Australia's mitigation R&D.

"Australia is a leader in clean energy technology and CSIRO's partnership with China's Thermal Focus takes our climate-mitigation focus to a global stage," Dr Marshall said.

"Through this collaboration and our continued solar research, we will be helping to generate cleaner energy, cost savings and technology export benefits for Australia; all lowering global greenhouse gas emissions."

Solar thermal technology uses a field of computer-controlled mirrors (heliostats) that accurately reflect and concentrate sunlight onto a receiver on top of a tower. The concentrated sunlight may then be used to heat and store hot molten salt, which can generate superheated steam to drive a turbine for electricity generation.

An advantage of this system is the very low cost of storing thermal energy, giving CST technology great potential for medium to large-scale solar power, even when the sun isn't shining. A heliostat field can represent up to 40 per cent of the total plant cost so low cost, high precision heliostats are a crucial component.

The licensing agreement with Thermal Focus follows CSIRO's successful international solar thermal partnerships with Japan's Mitsubishi Hitachi Power Systems, and the Cyprus Institute and Heliostat SA in Australia.

## CHRYSOS AND CSIRO ARE GOING FOR GOLD

CSIRO is partnering with Chrysos Corporation to bring to market its powerful PhotonAssay X-ray gold detection technology, setting its sights on a slice of the \$1 billion global gold assay business.

The PhotonAssay method uses high powered X-rays to bombard rock samples and activate atoms of gold and other metals. A highly sensitive detector picks up unique signatures from these elements to determine their concentrations.

Although the basic principles of this analysis method have been known for decades, the complex nature of the technology has meant that the technique has found only limited commercial application to date.

In an industry facing declining ore grades, rapid analytical technology has the potential to unlock substantial productivity gains in gold mining and production, and open up a significant new market for real-time analysis services in on-site applications.

Australian annual gold production is valued at about \$15 billion and continues to be a high performer in a global market worth over \$150 billion. Analytical services are an essential part of the mining value chain, from exploring for new deposits through to running profitable extraction operations.

Chrysos plans to deliver its first high-throughput analytical unit in late 2017 before rolling out smaller systems for mine-site operations the following year. Validation

of the PhotonAssay technology has been supported by industry partners including Newcrest Mining and Gannet Holdings. BHP Billiton and the South Australian Government have provided funding to support the commercialisation.

Chrysos will be headquartered in Adelaide and CSIRO will hold a 34 per cent stake in the company.

Although development has initially been focused on gold, the technology can be applied to a wide range of other metals and will support increased recovery and lower operating costs across exploration, mining and processing operations.



*A gold nugget.*

*• Chrysos, named for the Greek word for gold, is a public company whose investors include CSIRO, the former President of the predecessor of Barrick Gold (American Barrick Resources) Mr Anthony McLellan, investment advisers RFC Ambrian and a network of mining executives. It was founded in 2016 to commercialise the CSIRO-developed PhotonAssay technology.*

# NEWS

## Rare chance to reform electricity sector

Australia has a once-in-a-generation opportunity to reform the electricity sector to maximise its resilience in the face of rapid market changes, according to Australia's Chief Scientist Dr Alan Finkel AO FAA FTSE.

"The goal is to ensure we have a secure electricity supply, at an affordable price for all Australian consumers, while meeting our international obligations to lower emissions," he said.

Commenting on the Preliminary Report of the National Electricity Market (NEM) Security Review, Dr Finkel said the Review's investigations had highlighted the speed of change and the complexity of the NEM, the longest geographically connected power system in the world supplying 80 per cent of the nation's electricity.

"We are feeling the force of a global shift away from traditional electricity generation technologies to greater reliance on solar and wind generated electricity, which have very different characteristics," Dr Finkel said.

Residential consumers are helping to drive the transformation as they look to take charge of their energy use and bring down their bills. Australia leads the world in solar rooftop penetration per capita, with more than 1.5 million systems installed. More than 1 million home

battery storage systems are projected over the next 20 years.

"It is clear from our early consultations that investors are less confident today than they were in the past. There are solutions to the challenges we face and we will have to change the way we operate."

Dr Finkel acknowledged the outstanding and ongoing work of the four Review panel members, including Professor Mary O'Kane AC FTSE and Ms Chloe Munro FTSE, expert advisers and the members of the Review taskforce.

The Preliminary Report serves as an issues paper with a series of observations and questions to guide consultations and submissions, due by 21 February, which will inform the development of the blueprint in the Final Report – to be finalised mid-year.

Some key observations identified in the Preliminary Report include:

- the security and reliability of our electricity supply is less assured than in the past;
- the rate of technological change is unprecedented and consumer expectations are shifting rapidly;
- household energy bills rose on average almost 50 per cent (inflation adjusted) in the six years to 2014;
- inadequate supply and the high cost of natural gas are contributing to electricity price rises; and
- there is broad enthusiasm for a coordinated national approach to energy and emissions reduction policies.

## UNSW CLAIMS NEW SOLAR EFFICIENCY RECORD

They're flexible, cheap to produce and simple to make – which is why Perovskites are the hottest new material in solar cell design. And now, engineers at the University of New South Wales have achieved a new world efficiency record in solar cell design.

Dr Anita Ho-Baillie, Senior Research Fellow at the UNSW School of Photovoltaic and Renewable Energy Engineering and Program Manager for Perovskite Solar Cell Research at the Australian Centre for Advanced Photovoltaics (ACAP), has claimed for UNSW the highest efficiency rating with the largest Perovskite solar cells to date.

She said her UNSW team had achieved a 12.1 per cent efficiency rating for a 16 cm<sup>2</sup> perovskite solar cell, the largest single Perovskite photovoltaic cell certified with the highest energy conversion efficiency, independently confirmed by the international testing centre in Bozeman, Montana.

"This is a very hot area of research, with many teams competing to advance photovoltaic design," Dr Ho-Baillie said.

"Perovskites came out of nowhere in

2009, with an efficiency rating of 3.8 per cent, and have since grown in leaps and bounds.

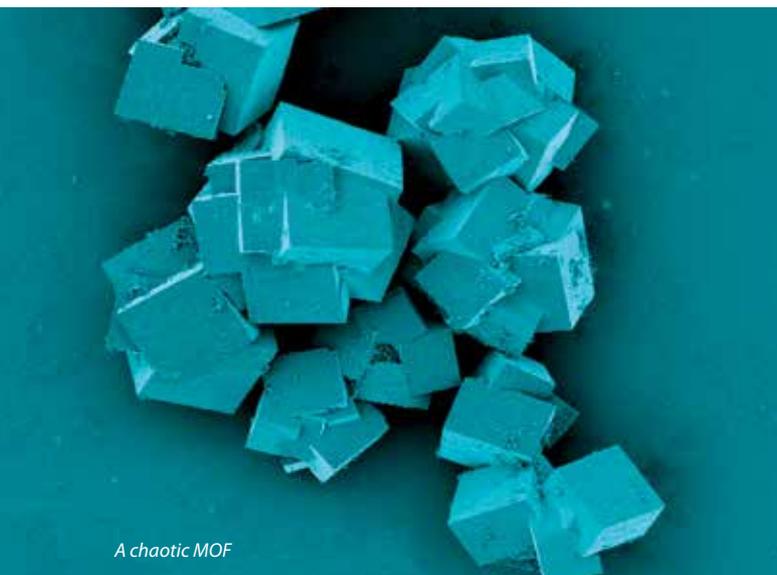
These results place UNSW amongst the best groups in the world, producing state-of-the-art, high-performance perovskite solar cells.

And I think we can get to 24 per cent within a year or so."

Perovskite is the fastest-advancing solar technology to date, and is attractive because the compound is cheap to produce and



Anita Ho-Baillie and Martin Green.



A chaotic MOF

## Designer crystals for drug advancements

A chemistry breakthrough led by Australian scientists could revolutionise healthcare by speeding the development of tiny devices supplying real-time information about a patient's condition.

simple to manufacture, and can even be sprayed onto surfaces.

But although Perovskites hold much promise for cost-effective solar energy, they are currently prone to fluctuating temperatures and moisture, making them last only a few months without protection. Dr Ho-Baillie's team is working to extend perovskites durability.

Most of the world's commercial solar cells are made from a refined, highly purified silicon crystal and, like the most efficient commercial silicon cells (known as PERC cells and invented at UNSW), need to be baked above 800°C in multiple high temperature steps.

But Perovskites, named for Lev Perovski, the Russian mineralogist who discovered the material, are made at low temperatures and are 200 times thinner than silicon cells.

"We will capitalise on the advantages of Perovskites and continue to tackle issues important for commercialisation, like scaling to larger areas and improving cell durability," said Professor Martin Green AM FRS FAA FTSE, Director of ACAP.

Collaborating with teams in Japan, Austria, Monash University and The University of Adelaide, CSIRO scientists have found a way to harness the potential of designer crystals known as metallic organic frameworks (MOFs) – the most porous materials on the planet.

Since their discovery in 1999, they have been used in an array of fields including pharmaceuticals, electronics and horticulture. Although the novel materials exert a powerful appeal for scientists, one of the roadblocks to realising the full potential of MOFs is their erratic structure, which makes it difficult to integrate them into functional devices.

"We've found a way to control the structure of MOFs and align them in one direction, creating a MOF film," said CSIRO scientist Dr Aaron Thornton, co-author of the paper published in *Nature Materials*.

"Having the MOFs in alignment means they conduct a current far better, opening up more electrical uses such as implantable medical devices that give real-time information about someone's health. It also gives researchers more control in the development of vaccines, which will fast-track the process.

"MOFs could also be structured in such a way that they'd only react with certain compounds or elements – for example, miners could wear clothes impregnated with a layer of MOFs that tell them when dangerous gases are building up."

CSIRO has already used MOFs to develop a molecular shell to protect and deliver drugs and vaccines, a 'solar sponge' that can capture and release carbon dioxide emissions and plastic material that gets better with age.

## TARGETING ASTHMA AND ALLERGIES

A new drug that 'fine tunes' the immune system is being developed to help prevent asthma and allergies to foods such as peanuts and shellfish.

Nobel Laureate Professor Barry Marshall AC FRS FAA, from The University of Western Australia, is developing an oral treatment called 'Imbalance', which is designed to restore balance to the immune system and desensitise allergic response.

Professor Marshall is looking to trial the drug on humans within two years and hopes to make Imbalance available within five years.



Barry Marshall addressing an ATSE audience in Perth in 2014.

## WMO SAYS 2016 OUR HOTTEST YEAR

The year 2016 was the hottest year on record, according to a consolidated analysis by the World Meteorological Organization (WMO).

The globally averaged temperature in 2016 was about 1.1°C higher than the pre-industrial period. It was approximately 0.83°C above the long term average (14°C) of the WMO 1961–90 reference period, and about 0.07°C warmer than the previous record set in 2015.

WMO uses data from the US National Oceanic and Atmospheric Administration, NASA's Goddard Institute for Space Studies, the UK's Met Office Hadley Centre and the University of East Anglia's Climatic Research Unit. WMO also draws on reanalysis data from the European Centre for Medium Range Weather Forecasts and the Copernicus Climate Change Service, which use a weather forecasting system to combine many sources of data to provide a more complete picture of global temperatures, including in polar regions.



BY ALAN FINKEL  
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PHOTO: SHUTTERSTOCK



Building maths skills.

# New 3Rs needed to reverse trends

**EDUCATION** While we demand to be top 10 in sport, we are barely scraping top 20 in schools. How much lower are we prepared to go?

**A**s a school student, I awaited the arrival of the end-of-year report with a bracing mix of hope and fear. Now, as Australia's Chief Scientist, I'm worried once again about school reports.

Our proudly first-class country, with a prosperous economy and an egalitarian spirit, must not be fair-to-middling when it comes to science and maths in schools. On the evidence before me, we are.

Do I believe that international testing

can capture everything of importance in Australian education? No. But do I take these findings seriously? Yes, I do.

Be it the international studies Program for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS), or the national scheme National Assessment Program – Literacy and Numeracy (NAPLAN), the message is clear.

Our performance in absolute terms is stalling, or in decline, and our position in global rankings continues to fall.

## INTERNATIONAL COMPARISONS

Canada now scores significantly higher across all PISA and Year 8 TIMSS domains. England has improved its TIMSS performance, while also decreasing the proportion of low-performing students.

Australia, by contrast, is one of only three countries with significantly decreased maths and science scores in this round of PISA. And the difference between children in Australia's highest and lowest socioeconomic quartiles recorded by PISA is the equivalent of three

full years of school.

While we demand to be top 10 in sport, we are barely scraping top 20 in schools. In PISA maths, we have fallen as low as 25. How much lower are we prepared to go?

My concern is not the temporary wound to national pride. It is the enduring harm we do when students leave school with malnourished potential – or worse, no interest at all – in disciplines that they require to navigate their world. We need to improve.

Let's start by defining the aim: the best possible education in maths and science (and literacy) for every child, irrespective of gender, region, income or incoming ability. In the 21st century, we can no more write off a child because "he's not into numbers" any more than we would accept that "she's not keen on the alphabet".

Maths is not just the language of science and technology, but the foundation of commerce, the core of engineering, and the bread and butter of every trade from cooking to construction.

How can we hold governments to account if journalists can't interpret data and citizens can't make sense of charts?

How can we resist the prophets of the post-truth world? When everything we value is at stake, surely nothing less than our utmost will do.

So with that aim in mind, let's agree to share the task: yes, we do bear individual responsibility; but, no, we cannot lay the blame solely on individuals, be they principals, teachers, parents or students. There is no point in exhorting individuals to aim high unless we help them to make the leap. If we want excellence, we have to provide a system with the incentives, enablers and rewards for improvement built in.

## POLICY RESPONSES

For me, that comes down to a new three 'Rs' for education.

**1 Restore maths prerequisites for courses** Restore meaningful maths prerequisites for all university courses that, no-one could argue, need numbers.

This would reverse the exodus from advanced maths courses and set students up for success – in commerce and accounting, as well as science and engineering. Just as importantly, it would give principals a reason to make the quality of their maths programs a priority all the way from kindergarten to Year 12.

**2 Respect teaching** The single most important factor in the classroom is the human up the front.

The education system must be engineered around that fundamental premise, so that high-achieving students become highly qualified teachers with well-targeted professional development. Crucially, teacher training and development need a strong discipline-specific focus. It should be expected that our science and maths teachers are experts in their fields, with both the technical and pedagogical knowledge to teach them well.

The Commonwealth Science Council strongly endorsed this principle at its last meeting, and requested the Department of Education to investigate options to bring it about.

**3 Recognise the influence of school leaders** Principals set the tone in their schools and, with the right strategic focus, they can drive a culture of constant improvement. Without that senior leadership, it is simply too hard for individual teachers to keep the bar consistently high – another reality the Commonwealth Science Council has acknowledged.

Of course, ambitious aims have investment pathways attached. But money spent is not a proxy for effort invested, and it is certainly not a reliable predictor of success.

As a businessman, I learned that no project delivers what you want unless the 'how' comes before the 'how much'.

Face the hard truths, aim high, be strategic – and we might just receive a school report we can be proud to display. ©

*• This article, By Dr Alan Finkel AO FAA FTSE, Australia's Chief Scientist, was first published in The Conversation.*

## MORE TRAINING, SAYS AMSI

Science teachers should be offered career incentives to take additional mathematics training to reduce out-of-field teaching, according to the Australian Mathematical Sciences Institute's (AMSI). AMSI's plan would see eligible science teachers undertake additional tertiary training in both content and pedagogy. An inbuilt requirement to remain at their current schools, many in regional and disadvantaged areas, for three years after completion would ensure skilled maths teachers remained where they are needed most, it says.

"Up-skilling those already on-the-ground to equip them with the understanding and confidence to teach mathematics, while retaining them in high-need schools, offers greater benefit to learning outcomes," says AMSI Director, Professor Geoff Prince.

The plan would particularly target biology teachers who are in high supply but have little mathematical background. With mathematics and statistics taking a key role in biological discovery, particularly through data science, building these linkages is essential, AMSI says.

"The widening gap between the proportion of high and low maths performers is particularly worrying. Mathematical literacy is essential to navigate so many areas of our lives," says Professor Prince.

"Without this cultural and social asset future generations are at serious disadvantage."

## \$20 BILLION EXPORT INCOME FROM EDUCATION

The education of international students generated a record \$20.3 billion in export income for Australia in 2015-16 – up eight per cent from the previous 12 months. New data released by the Australian Bureau of Statistics confirms that universities and other tertiary institutions generated \$13.7 billion of that income in 2015-16.

International education remains Australia's third largest export, behind iron ore and coal. It supports more than 130,700 Australian jobs and sustains Australian living standards. More than 320,000 students from 130 countries are currently studying at Australia's universities.

"Over the past 50 years, Australian universities have been the vanguard of Australia's engagement with our region," said Universities Australia Chief Executive Ms Belinda Robinson.

"The people-to-people links forged through international education create the country-to-country ties that help us all to prosper."

# NEWS

## Fund aims to supercharge Australian innovation

The CSIRO Innovation Fund, a \$200 million target fund to commercialise early stage innovations from CSIRO, universities and other publicly funded research organisations (PFROs), will realise part of the revenue from CSIRO's WLAN inventions.

The Fund aims to support co-investment in new spin-out and start-up companies and SMEs engaged in the translation of research generated in the publicly funded research sector.

Established as part of the National Innovation and Science Agenda, it will comprise a commitment of \$70 million in government funding, \$30 million revenue from CSIRO's WLAN program and additional private sector investment, with a target total value of \$200 million.

CSIRO Chief Executive Dr Larry Marshall FTSE said the Innovation Fund was the "final piece in the puzzle", revealing the vision set out in the organisation's Strategy 2020.

"We have aligned all the pieces: from market roadmaps that guide our science to address the most critical needs; to the ON sci-tech accelerator to help Australia's scientists apply their science for national benefit; and now we have the Innovation Fund to invest in those ideas and reap the rewards of their success," Dr Marshall said.

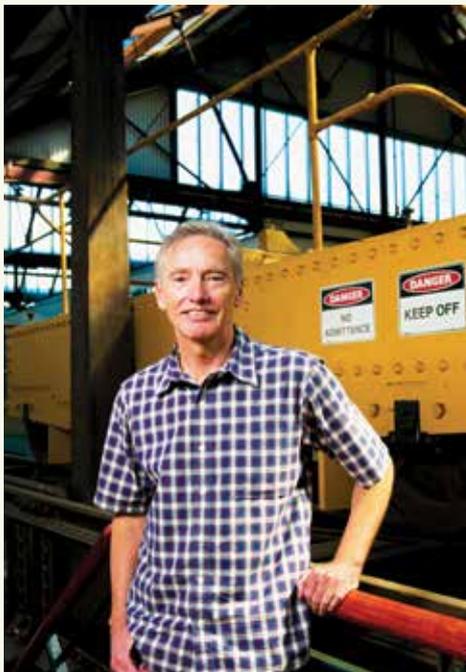
"It's a virtuous cycle of investment in taking our best ideas from bench-top to beta to buyer.

"This clears the pathway for science and technology to navigate Australia's future."

The CSIRO Innovation Fund will be managed by an experienced team led by veteran venture capitalist Mr Bill Bartee, who was appointed following an extensive recruitment process.

Additional management team members are currently being recruited and will join Mr Bartee in the first quarter of 2017.

"To ensure the best ideas have the greatest impact, we will back the most ambitious entrepreneurs who want to build important, enduring companies," Mr Bartee said.



Bill Bartee

## INNOVATION-ACTIVE BUSINESSES DO BETTER, SAYS REPORT

The Australian Government's 2016 edition of the *Australian Innovation System Report* confirms previous findings that innovation-active businesses perform better on a range of measures than non-innovators.

But the report suggests Australia's innovation performance is hampered by a falling proportion of business investment in R&D relative to GDP and low levels of business collaboration on innovation with the research sector.

It says one consequence of this is that Australia's new-to-market innovation ranks poorly against other countries and has declined since the years preceding the Global Financial Crisis.

It describes new initiatives such as the Business Longitudinal Analysis Data Environment (BLADE), which integrates linked longitudinal datasets, allowing a deeper and wider analysis of business data over time. New measures of the frequency and persistence of innovation activity are presented as well as a measure of innovation's impact on businesses' revenue.

It also provides:

- an overview of Australia's innovation system performance across its many activities, from research and development (R&D), through business-research collaboration to commercialisation and intellectual property protection;
- insights into how innovation drives growth and competitiveness, and measuring its impact on business performance indicators such as sales, exports and employment;
- publicly accessible data on innovation indicators; and
- case studies and feature articles supplementing the data analysis.

Copies of the report are available on the Department of Industry, Innovation and Science's website ([industry.gov.au](http://industry.gov.au)).



## MINERALS TAX RATE TOPS 54 PER CENT

The minerals industry faced an effective tax rate of 54.3 per cent in 2014-15, the highest burden for nearly a decade, according to a survey for the Minerals Council of Australia (MCA) by Deloitte Access Economics.

The 2016 MCA Annual Tax Survey, which measures the combined effective tax rate of company tax and royalties, showed that more than half of the industry's profits (taxable income adjusted for royalties) are paid to federal and state governments.

MCA said that, with lower profits in the period, royalties accounted for 60 per cent of tax collections in 2014-15. The high proportion of royalties reflected the fact that royalties do not take account of the profitability of the sector, which saw tough conditions in 2014-15.



Entrance to Yeelirrie Station.

## Yeelirrie uranium project gets green light

The Western Australian Government has granted environmental approval for Cameco's Yeelirrie uranium project, subject to 17 strict conditions.

This takes to four the number of uranium projects given the 'go ahead' in Western Australia, with the potential to create 1500 jobs and a \$1 billion a year export industry.

The decision follows a rigorous environmental assessment process, significant public consultation and agreement between the Environment Minister and the Ministers for Water, Mines and Petroleum, Aboriginal Affairs and State Development.

WA Premier Mr Colin Barnett said Western Australia had very significant uranium reserves and the Yeelirrie deposit was particularly large by world standards.

"Australia has been producing and exporting uranium for peaceful purposes for more than 30 years and it is high time that Western Australia, with our significant reserves, became part of that industry," Mr Barnett said.

"Australia's international treaties guarantee that uranium can only be used for peaceful purposes. We should also remember that nuclear medicine is also an important part of our healthcare system."

Mr Barnett said he looked forward to Western Australia becoming a significant uranium producer, as South Australia, Queensland and the Northern Territory already are.

The four approved uranium proposals are Vimy Resources' Mulga Rocks, Toro Energy's Wiluna uranium proposal and Cameco's Kintyre and Yeelirrie projects.

The Minerals Council of Australia (MCA) welcomed the news, saying that, while these approvals came at a time of challenging uranium market conditions, they were important steps in readying these projects for when new production is required to meet market demand.

Australia, with almost one-third of global uranium resources, is responsible for about one-tenth of world production, and there is opportunity to expand uranium production and exports as the

*"Australia's international treaties guarantee that uranium can only be used for peaceful purposes. We should also remember that nuclear medicine is also an important part of our healthcare system."*

– COLIN BARNETT

global nuclear industry expands in the decades ahead, MCA said.

Nuclear power is a mature electricity-generating technology deployed globally, and expanding rapidly in the world's two most populous nations – 27 of the 60 reactors currently under construction in the world are being built in China and India, two of Australia's key trading partners, it said.

Cameco is one of the world's largest publicly traded uranium companies. Its two flagship projects in Western Australia are Kintyre, a joint venture with Mitsubishi, located in the Eastern Pilbara and acquired from Rio Tinto in 2008, and Yeelirrie.

Yeelirrie is one of Australia's largest undeveloped uranium deposits. Cameco is the owner and operator of the project, acquiring Yeelirrie from BHP Billiton in 2012. The deposit is located in the Northern Goldfields region of Western Australia, about 420 kilometres north of Kalgoorlie. Yeelirrie was originally discovered in 1972 by Western Mining Corporation (WMC).

Toro's Wiluna uranium project is centred on its planned processing facility located 30km south of the town of Wiluna in the Northern Goldfields. Vimy's Mulga Rocks Project is located 240km east-north-east of Kalgoorlie in the Great Victoria Desert.

### ADELAIDE TO HOST 2019 PHYSICS OLYMPIAD

Adelaide will host the annual Asian Physics Olympiad in May 2019 which, in a first for Australia, will bring 200 of the region's most outstanding secondary students from 25 countries to Australia.

Mr Trevor Danos AM, Chair of the Asian Physics Olympiad 2019 Organising Committee, said this offered an opportunity to position Australia at the forefront of innovation and demonstrate the country's growing commitment to the science, technology, engineering and mathematics (STEM) disciplines.

Australia has been competing in the Asian Physics Olympiads since it began in 2000, under the auspices of Australian Science Innovations (ASI). Each competing country sends a team of eight competitors. Exams are undertaken individually, with bronze, silver and gold medals awarded to high-scoring students.

Australian Science Innovations is an independent, not-for profit organisation committed to contributing to building Australia's scientific community through inspiring and developing our best science students.

# NEWS

## Twenty-five new species of rays now named

The newly released book *Rays of the World* is the result of research across the globe resulting in the naming of 633 species of rays, many previously unknown to science, including 25 new species not named or described until 2016.

Thanks to Australia's unique biodiversity, many of the newly described species are Australian.

The Australian Whipray, a familiar sight in Queensland's Noosa River, was described and named in recent months. As was the the Mumburarr Whipray, found in northern Australia and Papua New Guinea, which is one of largest stingrays – measuring more than 1.6 metres across its disc and more than 4m in length, and weighing more than 100 kilograms.

The book, published by CSIRO Publishing, was funded by the US National Science Foundation, CSIRO Oceans and Atmosphere, and CSIRO's Australian National Fish Collection and is the first illustrated guide to rays since the first member of the group was described by Linnaeus, the founder of modern taxonomy, in 1758.

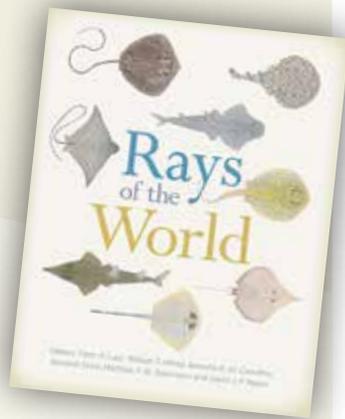
The group includes well-known creatures such as stingrays, skates, electric rays and sawfishes. They range in size from seven metre-wide mantas and seven metre-long sawfish to the tiny electric sleeper ray, which reaches maturity at only eight to 10 centimetres long.

Most live only in the sea, but the freshwater stingrays of South America spend their lives far upstream in rivers, including the Amazon.

"Some of the species celebrated in our book may be rendered extinct in the near future without intervention, including many stingray species from South-East Asia," lead editor and CSIRO researcher Dr Peter Last said.

"Tasmania's largest endemic fish, the Maugean Skate, is in danger of joining the Thylacine."

The research underpinning *Rays of the World* proved challenging, with the authors searching natural history collections and museums around the world, including CSIRO's Australian National Fish Collection in Hobart, as well as searching for rays in the wild and at remote fish markets.



Artist's impression of the increasing effect of ram-pressure stripping in removing gas from galaxies, sending them to an early death.

## GALAXY MURDER MYSTERY?

It's the big astrophysical 'whodunnit'. Across the universe, galaxies are being killed and astronomers want to know what's killing them.

New research published by a global team of researchers, based at the International Centre for Radio Astronomy Research (ICRAR) in Western Australia, reveals that a phenomenon called 'ram-pressure stripping' is more prevalent than previously thought, driving gas from galaxies and sending them to an early death by depriving them of the material to make new stars.

The study of 11,000 galaxies shows their gas – the lifeblood for star formation – is being violently stripped away by ram-pressure stripping, which removes gas very quickly in astronomical terms, in the order of tens of millions of years.

This contrasts with strangulation, which researchers says is a slow-acting process that occurs when the gas is consumed to make stars faster than it is being replenished, so the galaxy starves to death.

The study was published in the journal *Monthly Notices of the Royal Astronomical Society*.

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

## INTERGALACTIC GAS CALM, SAYS PARKES

A brilliant flash of radio waves from the distant universe, captured and analysed recently by a mostly Australian team, using CSIRO's Parkes telescope, has given a unique glimpse of the gas that lies between galaxies.

Called fast radio bursts (FRBs), such cosmic flashes were discovered with Parkes in 2007.

Just 18 have been spotted to date. Astronomers think that between 2000 and 10,000 go off all over the sky every day but their cause is unknown.

Coming from a small patch of sky containing only distant galaxies, the flash in question, FRB 150807, seems to have originated more than a billion light-years away and offered an unprecedented view of the thin gas in space between galaxies.

Intergalactic gas, also called the cosmic web, 'feeds' galaxies, making them grow. It can alter radio waves passing through it, like a stained-glass window colouring light.

The 'imprint' on FRB 150807 showed that the intergalactic gas is calm and has very weak magnetic fields, qualities scientists had predicted but were unable to measure until now.

FRB 150807 was found with a real-time detection system developed by Swinburne University of Technology that is used on the Parkes telescope to study pulsars and FRBs.



CSIRO is investing in a next-generation computer to replace the Bragg.

## \$4 million for new CSIRO petaflop computer

CSIRO is in the market for the next generation of supercomputer to replace its current Bragg accelerator cluster.

Bragg's replacement will be capable of 'petaflop' speeds, significantly exceeding the existing computer's performance. It will boost CSIRO's already impressive high-performance computing (HPC) capability and is expected to rank highly on the Green500 list, which ranks the top 500 supercomputers in the world by energy efficiency.

Bragg was ranked seventh on the Green500 in 2014.

In addition to being a key partner and investor in Australia's national peak computing facilities, the science agency is a global leader in scientific computing and an early pioneer of graphics processing unit-accelerated computing in Australia.

The cluster will power a new generation of ground-breaking scientific research, including data analysis, modelling and simulation in a variety of science domains such as biophysics, material science, molecular modelling, marine science, geochemical modelling, computational fluid dynamics and, more recently, artificial intelligence and data analytics using deep learning.

The tender, which closed on 19 December 2016, seeks a 'heterogeneous' system combining traditional central processing units with coprocessors to accelerate both the machine's performance and energy efficiency. The successful bidder will be asked to deliver and support the system for three years within a \$4 million proposed budget.

The winning system is expected to be up and running during the first half of 2017.

## ASKAP NOW PROCESSING HUGE AMOUNTS OF DATA

One of the world's most powerful radio telescopes, based in the Western Australian outback, has begun processing mind-boggling amounts of data which will help scientists explore the secrets and history of the universe.

The antennas of CSIRO's \$188 million Australian Square Kilometre Array Pathfinder (ASKAP) telescope are now processing 5.2 terabytes of data per second – the equivalent of around 15 per cent of global internet traffic.

Situated 300 kilometres inland from Geraldton in one of the quietest places on Earth, ASKAP is made of 36 identical 12-metre-wide dish antennas that all work together, 12 of which are currently in operation.

The telescope's antennas feature innovative 'phased array feed' technology, specialised radio 'cameras' that look at a large area of sky at once, developed by CSIRO for ASKAP.

ASKAP is a precursor of the global Square Kilometre Array (SKA) project involving 20 countries, which will create the largest and most capable radio telescope ever constructed. This will help scientists answer some of the most fundamental scientific questions about the origins of the universe, such as:

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

Turning data into images used to take weeks of toil but the revolutionary ASKAP technology does it overnight. Astronomers are using these observations to look for hydrogen gas – the raw material for making stars – in and around galaxies. This is the first step in making a census of hydrogen in galaxies far back in the universe's history.

ASKAP's phased array feed technology has attracted international interest, with CSIRO recently building one under contract for Germany's Max Planck Institute for Radio Astronomy and contracted to supply a second to Jodrell Bank Observatory in the UK.

The telescope data is processed onsite by a special-purpose computer then streamed to the Pawsey Supercomputing Centre in Perth. The data is then processed by CSIRO-developed software on the 'Galaxy' supercomputer and recorded

to disk, at the rate of 956 gigabytes for each 12-hour observation.

Thirty ASKAP antennas have been fitted with phased array feeds, with the rest to follow in 2017.

In the second half of 2017, more than 350 astronomers from more than 120 institutions will start to use ASKAP for 10 major survey science projects.



Ten ASKAP dishes at the Murchison Radio Observatory site in WA.

# NEWS

## Telehealth alliance targets 20,000

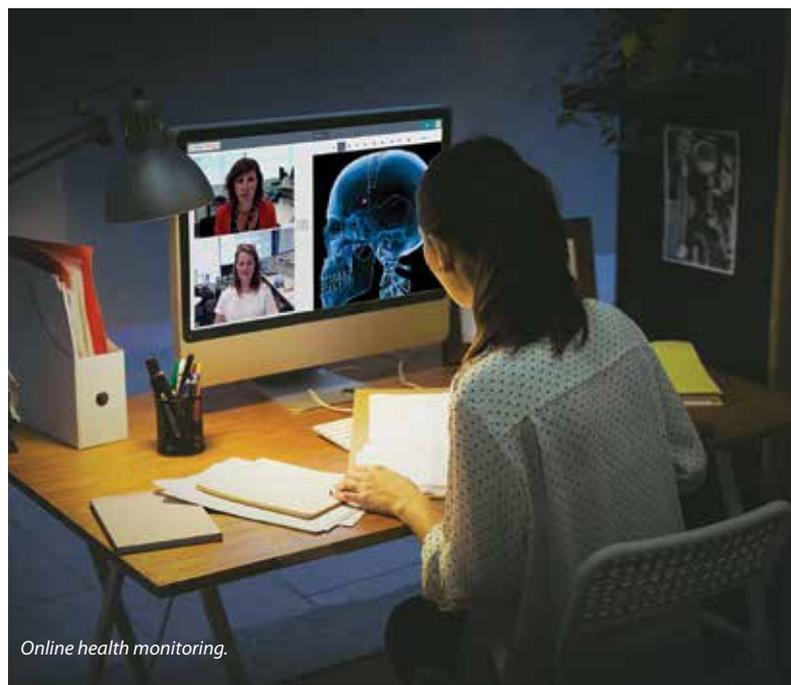
A partnership between CSIRO's Data61 and regional allied health network Health Team Australia (HTA) is helping address inequities in rural and remote areas by providing a telehealth solution, expected to connect up to 20,000 patients with online healthcare professionals.

An alliance between HTA and CoviU, a CSIRO Data61 project, is enabling CoviU's real-time communication online video platform rolled out to HTA customers across Australia, extending existing healthcare solutions and services from professionals such as exercise physiologists, dieticians, psychologists, mental health nurses and occupational therapists.

The online service will be offered to patients via a range of partners across Australia. YMCA in Victoria, NSW and the ACT has already begun delivering these services to metropolitan communities and are now extending their health plan and coaching services to those without access to a local YMCA.

CoviU Project Director Dr Silvia Pfeiffer said the platform was designed to integrate into existing workflows, allowing practitioners to live-share medical data and images.

"About 10 per cent of the Australian population is spread across 90 per cent of its area, and these people have poor access to medical specialists that's taken for granted in large metropolitan areas," Dr Pfeiffer said.



Online health monitoring.

An analysis of Medicare statistics from 2016 showed that less than four per cent of health practitioners in private practice currently provide telehealth services to their patients. Almost 50 per cent of Australians suffer chronic diseases such as cancer, mental health or diabetes and a further 13 million are at risk of developing chronic disease.

## FLOW CHEMISTRY TO AID MANUFACTURING

CSIRO has launched its Centre for Industrial Flow Chemistry in Melbourne – named 'FloWorks' – which it says will provide cutting-edge research into flow chemistry capability, making it more accessible to the chemical manufacturing industry.

Senior research scientist with CSIRO's manufacturing sector and Director of the new centre, Dr Christian Hornung, said flow chemistry offered a cleaner, smarter and more efficient way of making chemicals.

"The benefits of using the flow process include reduced reaction times and plant space, which equate to less energy cost, more efficient processes, reduced waste and a much safer environment," Dr Hornung said.

Unlike traditional batch chemistry methods, starting materials are fed into a reactor where the chemical reaction takes place in a continuous stream, a method that in many cases has proven to be a more efficient and cost-effective way of producing chemicals.

Multi-stage processing, which eliminates the need for manual handling of chemicals in

between steps, greatly improves safety, while in-line purification makes the system more streamlined.

Smart monitoring and on-line analysis is used to automate the manufacturing process.

FloWorks occupies a purpose-built 410m<sup>2</sup>

facility that will be housed at CSIRO's Clayton site in Melbourne's south east. Incorporating all of CSIRO's flow chemistry equipment, its capabilities will range from small-scale discovery tools to large-scale industrial reactors.



Dr Christian Hornung works on an industrial-scale reactor at FloWorks.

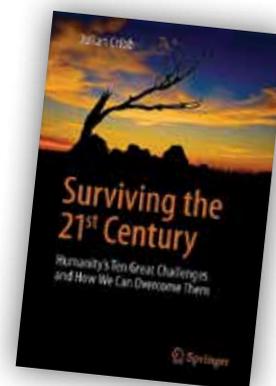


BY IAN RAE  
iandrae@bigpond.com

# Are you up for Ten Great Challenges?

## BOOK REVIEW

*Surviving the 21st Century: Humanity's Ten Great Challenges and How We can Overcome Them* by Julian Cribb (Springer, 2017, xiv + 253 pp).



**1** Julian Cribb is a Fellow of the Academy and author of more than 8000 articles, 3000 media releases and nine books. In *The Coming Famine* and *Poisoned Planet* (earlier books) he warned of existing problems that are likely to get worse. In *Surviving the 21st Century* these are joined by other challenges to humanity.

**2** The challenges come from loss of species, environmental degradation, warfare, global warming, toxic substances, food profligacy, unrestrained technology, population growth and lack of foresight. Drawing up a list with nice round numbers means that Mr Cribb has struggled at times to fit his worries into his chosen categories. The index is rather too brief for such a richly packed book. It doesn't even include one of his favourite topics – women running the world (which does feature in the book and in the publisher's press release) – nor the nine environmental boundaries beyond which humanity ought to venture ... for its own safety.

**3** Mr Cribb argues that *Homo sapiens sapiens* – 'sapiens' meaning 'wise' – should be renamed because in our unwisdom we are stuffing up the planet, harming ourselves and other species as we do. No specific alternative is offered, however.

**4** The chapters have catchy titles. The one dealing with environmental degradation is 'The Degraded'. But they also come with Latin tags, in this case *Homo eversator*. Since

most of us know very little Latin, this is pretentious, and by the time we get to *Homo urbanus* and *Homo delusus* it is just twee.

**5** Each chapter ends with a list of imperatives and suggested actions. 'What We Must Do', is presumably addressed to governments or supra-governmental organisations, while 'What You Can Do' is more about personal responsibility. 'Don't buy products or shares in companies' of certain kinds is clear; exhortations to 'live a more sustainable life' and 'take a moral stand against (whatever it is) are more nebulous; and 'as a voter, demand laws that ...' spills over into the 'we' category.

**6** A curse was placed on Cassandra that nobody would believe her predictions, but commentators nowadays have elaborated on that simple scenario and they place Cassandra in the category of those who exaggerate in order to draw attention to problems that are nonetheless real. Read this book with both views in mind.

**7** We can suspect advocates and journalists of the careless use of figures. For example, I found "Tonight around two hundred thousand more people will sit down to dinner than dined last night" (page 125). No they won't. We can estimate that half that number of people will have died in the past 24 hours. The numbers change all the time, but when I checked they were 219,000 and 92,000, respectively.

**8** This book is heavily referenced, with many references of recent date. They constitute an excellent reading list for those who wish to delve further.

**9** Economist Bjorn Lomborg, widely vilified for underplaying the importance of global warming and climate change, had a valid point when he suggested that a broader view was needed of how to allocate limited resources across a range of challenges. Mr Cribb is not an economist and so I should not expect to see his proposals costed, but deciding where to spend, and how much to spend, should be on the mind of any decision-maker who picks up this book. Triage, unfortunately, is the name of the game.

**10** In the spirit of Lomborg, in addressing the question of how we can survive the 21st century, we might ask 'should we?' Philosopher Peter Singer reasons in *Ethics in the Real World* (2016) that the planet and other species would be better off if humans simply stopped breeding. ☺

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

# ATSE PEOPLE



Min Gu

## Victoria Prize for Min Gu

Professor Min Gu FAA FTSE has been awarded the 2016 Victoria Prize for Physical Sciences. Professor Gu is Associate Deputy Vice-Chancellor for Research Innovation and Technology at RMIT University.

The Prize recognises the outstanding work of established Victorian scientists and the impact of their research and is administered by veski on behalf of the Victorian Government.

The \$50,000 Victoria Prize for Physical Sciences recognizes Professor Gu's ground-breaking research in optical data storage, which has made significant improvements to data-

storage systems, allowing data that would ordinarily fill a football field to now be stored on a single DVD.

The award noted that Professor Gu's additional work in solar cell technology could reduce energy consumption by 1000 times, as well as the cost of solar cells themselves, making them more accessible for the building sector.

Professor Gu took up his current role in 2015. Before that he was Director of the Centre of Micro-Photonics at Swinburne University of Technology, where he was appointed Pro Vice-Chancellor (Research Capacity) in 2009.

He has been a Node Director the ARC Centre of Excellence for Ultrahigh Bandwidth Devices for Optical Systems (CUDOS) since 2003 and a node leader of the Australian Cooperative Research Centre for Polymers since 2005. He is also Director of the Victoria-

Suntech Advanced Solar Facility, which he initiated and established in 2010.

Professor Gu is a pioneer and an internationally leading authority on three-dimensional optical imaging science. He is sole author of two standard reference books and first author of the book published by Cambridge University Press. He has more than 800 publications (including more than 400 papers in internationally refereed journals including *Nature*, *Nature Photonics* and *Nature Communications*) in nano/biophotonics.

He has won many awards, including: Thousand Talents Award, Ministry for Education of China (2009); Einstein Professorship Award, Chinese Academy of Sciences (2010); Beattie Steel Medal, Australian Optical Society (2011); and Ian Wark Medal, Australian Academy of Science (2014).

## CRAIG SIMMONS WINS NEW WATER HONOUR

Groundwater research and training pioneer Professor Craig Simmons FTSE has been honoured by the Australian Water Association for his contribution to the industry.

Professor Simmons, director of the National Centre for Groundwater Research and Training (NCGRT) based at Flinders University, won the Water Professional of the Year at the South Australian Water Awards in Adelaide.



Craig Simmons

The awards acknowledge innovative excellence, creative solutions and exceptional leadership by individuals and organisations in the water sector.

The 2015 SA Scientist of the Year, Professor Simmons established the NCGRT to expand national and international research and training in groundwater science, education and policy reform. He

has been a significant contributor to global advances in the science of hydrogeology.

NCGRT recently joined the Groundwater Solutions Initiative for Policy and Practice, a partnership led by the International Water Management Institute that aims to further connect and strengthen current groundwater initiatives.

Protecting and improving groundwater resources is seen as vital to the future of adequate and safe water supplies to most countries, Professor Simmons says.

"In Australia, groundwater accounts for around one-third of our total water consumption and in the past few decades Australia has more than doubled its groundwater use," he says.

"This will increase in the future as we strive to meet the water needs of a rapidly growing population, our native landscape, expanding industries and agriculture, all of which must coexist under the increasing pressure of climate change."

## WIN FOR TREVOR BIRD

Professor Trevor Bird has been awarded the James R James Lifetime Achievement Award of the Institution of Engineering and Technology (IET).

The Award, founded to recognise outstanding contributions to the field of antennas and propagation, was presented to him by Professor Yiannis Vardoxoglou FEng, of Loughborough University, at the Loughborough Antennas and Propagation Conference in the UK.

IET is the largest multidisciplinary professional engineering institution in the world, formed in 2006 from the Institution of Electrical Engineers and the Institution of Incorporated Engineers, with membership of more than 167,000.



Trevor Bird (right) receives his award from Yiannis Vardoxoglou.

# ATSE PEOPLE

## Dick Kell wins Peter Nicol Russell Medal

Mr Richard (Dick) Kell AM FTSE, Chair of ATSE's Batterham Medal Selection Committee and Chair of the Warren Centre at the University of Sydney, was awarded the Peter Nicol Russell Memorial Medal at the Australian Engineering Excellence Awards in Brisbane in November.

Mr Kell began practising engineering in 1960 and built his own engineering firm, which merged with Cardno. He led Cardno as Chairman of the Board and then Executive Director after the company's ASX listing in 2004.

He is a Past President (2003–05) of the International Federation of Consulting

- Mr John Laurie AC FTSE (2004);
- Dr Arthur Bishop FTSE (2003);
- Dr Ken Michael AC FTSE (2002);
- Mr Wal King AO FTSE (2001);
- Dr Tom Connor AO FTSE (2000);
- Adj Professor Don Fry AO FTSE (1999);
- Dr John Nutt AM FTSE (1998);
- Dr Peter Miller AM (1997);
- Professor Jorg Imberger AM FAA FTSE (1995);
- Dr Robert Culver AM FTSE (1994);
- Mr Harold Clough AO OBE FTSE (1993);
- Dr Michael Sargent AM FTSE (1992);
- Professor Rolf Prince AO FEng FTSE (1991);
- Mr Donald Little AO FTSE (1990);
- Dr Charles Warman AM FTSE (1989);



Dick Kell (left) receives his award.

Engineers and was awarded his AM in 1998 for his service to the engineering profession, his expertise in bridge engineering, and his profile internationally.

Previous winners of the Peter Nicol Russell Memorial Medal over the past 40 years include an array of Academy Fellows and former Fellows:

- Sir Eric Neal AC CVO FTSE (2015);
- Dr Max Lay AM FTSE (2014);
- Mr John Grill AO FTSE (2012);
- Professor Mike Dureau AM FTSE (2009);
- Mr Martin Thomas AM FTSE (2008);
- Mrs Else Shepherd AM FTSE (2007);
- Dr Peter Farrell AM FTSE (2006);
- Professor Graeme Jameson AO FEng FAA FTSE (2005);

- Em Professor Peter Fink FTSE (1988);
- Professor John Crisp AM FTSE (1987);
- Em Professor Lance Endersbee (1986);
- Sir William Tyree Kt OBE FTSE (1985);
- Mr Douglas Price AM FTSE (1984);
- Em Professor Kenneth Hunt FTSE (1983);
- Mr Donald Aitken AO ISO FTSE (1982);
- Dr William Brown AM FTSE (1981);
- Mr Roger Morse AO FTSE (1980);
- Sir Charles Barton FTSE (1978); and
- Sir Louis Matheson KBE CMG FTSE (1976).

Earlier winners include Sir Ian McLennan KCMG KBE FAA FTSE (1967) and Sir John Holland AC FTSE (1974) – Foundation President and Foundation Treasurer (respectively) of the Academy.

■ *The Peter Nicol Russell Memorial Medal – Career Achievement Award in Engineering is the most prestigious award conferred by Engineers Australia. It is presented annually to an Honorary Fellow of Engineers Australia who has made a notable contribution to the science and/or practice of engineering in Australia. The award perpetuates the memory of Sir Peter Nicol Russell, a Sydney industrialist during the latter half of the 19th century, who made major donations to the cause of engineering in Australia.*

## RICHARD LARKINS NOW LA TROBE CHANCELLOR

Professor Richard Larkins AO FTSE will succeed Professor Adrienne Clarke AC FAA FTSE as Chancellor of La Trobe University in February.

Professor Larkins, a Fellow since 1998, is a former Vice-Chancellor of Monash University (2003–09).

He has wide experience in academia and government organisations. He held the James Stuart Chair of Medicine at Royal Melbourne Hospital and later served



Richard Larkins

as Dean of Medicine, Dentistry and Health Sciences at the University of Melbourne, and as Vice-Chancellor and President of Monash University.

He is currently Chair of the Victorian Comprehensive Cancer Centre and has also served as Chair of the National Health and Medical Research Council of Australia, President of the Royal Australasian College of Physicians, Chair of Universities Australia and as a member of the Prime Minister's Science, Engineering and Innovation Council.

Professor Clarke headed the Plant Cell Biology Research Centre at the University of Melbourne from 1982 to 1999.

She is a former chairman of CSIRO and Lieutenant Governor of Victoria. She has been a director of a number of public companies, including Alcoa of Australia Ltd, WMC Resources Ltd, Woolworths Ltd, Fisher and Paykel Healthcare Ltd and Hexima Ltd.

She has served on a number of Government Boards/Committees including the Prime Minister's Science and Engineering Council and the Victorian Innovation Economy Advisory Board.

She is author of four major scientific books dealing with chemistry, cell biology and genetics, and is a Foreign Associate of the National Academy of Sciences (USA), a Foreign Member of the American Academy of Arts and Sciences, and a Fellow of Janet Clarke Hall in Melbourne.

# ATSE PEOPLE

## Peter Høj heads Go8 grouping

University of Queensland (UQ) Vice-Chancellor and President Professor Peter Høj FTSE is the Chair for 2017 of the Group of Eight (Go8) universities, succeeding Dr Michael Spence, Vice-Chancellor of the University of Sydney.



Peter Høj

Professor Høj had broad working experience at executive level in industry, government and universities before becoming Vice-Chancellor of UQ

in October 2012. In his four years at the helm he has led the university to a premier position in global research and commercialisation, and overseen the development and implementation of a focused international strategy.

Ms Vicki Thomson, Go8 Chief Executive, said the Go8 looked forward to utilising the experience, determination and energy of Professor Høj.

"Professor Høj is recognised for his strong advocacy of both research and a commitment to excellence in teaching," she said. "We are keen to harness that on the Go8's behalf as we work to secure long-term sustainable policy and funding direction from Government."

Prior to his UQ appointment Professor Høj was Vice-Chancellor and President of the University of South Australia from June 2007. Before that, he was Chief Executive Officer of the Australian Research Council (2004–07)

and Managing Director of the Australian Wine Research Institute (1997 to 2004).

He was educated at the University of Copenhagen, majoring in biochemistry and chemistry, and has a Master of Science degree in biochemistry and genetics, a PhD in photosynthesis, an Honorary Doctorate from the University of Copenhagen and an Honorary Doctorate from the University of South Australia.

Professor Høj is a member of the Medical Research Future Fund Advisory Board, Co-Deputy Chair of the Strengthened Export Controls Steering Group, a member of the edX University Advisory Board and a member of the STEM Male Champions of Change.

He served on the CSIRO Board (2011–14) and was Deputy Chair of the Universities Australia Board (2011–13). He served as a private member of the Prime Minister's Science, Engineering and Innovation Council (1999 to 2004) and as an ex-officio member (2006–07).

## JOHN CHURCH MOVES TO UNSW POST

Dr John Church FAA FTSE, one of the world's leading experts on sea level rise caused by global warming, has been appointed a professor at the University of NSW's Climate Change Research Centre. Dr Church joined UNSW after a long career at CSIRO, most recently in Hobart.

Described as one of the "sharpest research brains in climate science", Dr Church is perhaps best known for his groundbreaking work that underpins our understanding of the threat of future sea level rise.

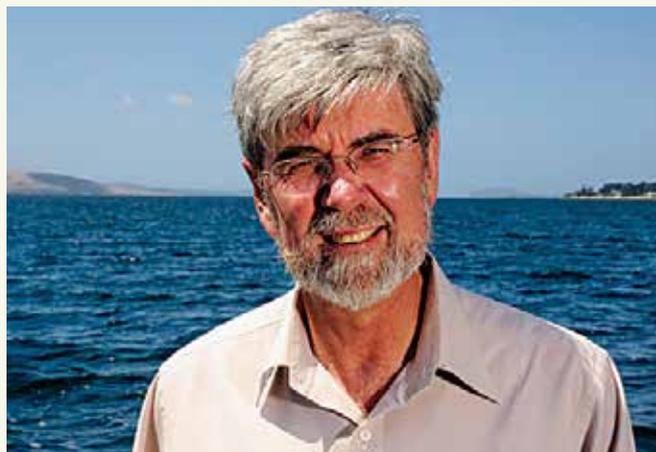
Dr Church's list of accomplishments is extensive. He has twice served on the United Nations' Intergovernmental Panel on Climate Change as Convening Lead Author on its chapter on sea levels. He received the Roger Revelle Medal from the Intergovernmental Oceanographic Commission in 2006 – the same year he won the CSIRO Medal for Research Achievement. He won the Eureka Prize for Scientific Research in 2007, and in 2008 he presented the R.H. Clarke Lecture for the Australian Meteorological and Oceanographic Society.

With a strong publication record of more than 150 journal articles, including numerous *Nature* publications, Dr Church has more than 25,000 career citations.

"John Church is the world's pre-eminent expert in global sea-level rise, with a stellar track record of research in oceanography and climate system science," said Professor Nicholas Fisk,

UNSW's Deputy Vice-Chancellor (Research).

"John has made vital discoveries in how the ocean regulates our climate system and how the oceans will respond to global warming," he added.



John Church



Frank de Hoog

## HANNAN MEDAL TO FRANK DE HOOG

Dr Frank de Hoog, a world-renowned Data 61 mathematician, has won the 2017 Hannan Medal, awarded by the Academy of Science. He is recognised internationally for his original and insightful contributions to the advancement of applied, computational and industrial mathematics. He is acknowledged by his peers as having contributed substantially to the mathematics profession. The importance and significance of his theoretical and applied contributions, and their flow-on contributions to the advancement of science and to improving the efficiency of industrial processes, have been recognised by various awards. The AAS noted the impact of his industrial research has been exceptional in terms of the speed of implementation by industry and the subsequent contributions to Australia's export economy.

# ATSE PEOPLE

## Bob Durie widely known as energy technologist

Dr Bob Durie FTSE was a leader in the world of energy technology and an influential member of the Academy, of which he was a member for 40 years.

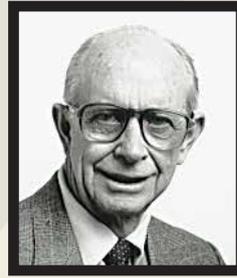
Educated at the University of Sydney, the University of London and Imperial College London, he started his career with the Propulsion Research Laboratories at Australia's Long Range Weapons Establishment in South Australia.

This preceded a 25-year career with CSIRO, during which he became Chief Research Scientist and Leader, Fuel Chemistry Section, in the Division of Process Technology, in 1977.

He had earlier been Assistant Chief, CSIRO Division of Coal Research, and Assistant Chief, CSIRO Division of Mineral Chemistry.

Dr Durie, a Fellow since 1976, died in Sydney on 5 December, aged 90.

He served for nearly 10 years until 1987 as Chief Scientist for R.W. Miller & Co, then a major Australian coal company, where he acted



Bob Durie

as a consultant on coal production and marketing management, exploration, coal quality and technological aspects of coal utilisation.

Over his career he worked with various state energy suppliers and Pohang Iron and Steel, in Korea, on coal combustion issues.

Since leaving R.W. Miller, he consulted widely on coal assessment and utilisation to major private and public-sector

organisations. He held a wide range of industry and government roles, including member of the NSW Science and Technology Council (1980–93) and Australian Government Representative (1986–93) on the UN/ECE Coal Committee in Geneva.

Dr Durie played a strong role with the Academy, serving almost continuously on Council for 14 years, and serving as Chair of the Membership Committee (1985–88) and the NSW Division (1980–82).

He was a Chartered Chemist and Chartered Engineer, and a Fellow of the Royal Society of Chemistry, the Royal Australian Chemical Institute, the Institute of Energy and the Australian Institute of Energy, as well as the Australian Institute of Mining and Metallurgy.

### FELLOWS MAKING AN IMPACT

#### Vaughan Beck

Dr Vaughan Beck AM FTSE, formerly Technical Director in the ATSE Office, has been appointed by the Northern Territory Government to the panel that will conduct an independent scientific inquiry into hydraulic fracturing in the NT.



#### Ron Cameron

Dr Ron Cameron FTSE, Head of the Nuclear Development Division at the OECD Nuclear Energy Agency in London, received the Australian Nuclear Association 2016 Award in December for outstanding contributions to nuclear science in Australia.

#### Ros Dubs

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, which is an Adelaide-based government naval shipbuilding business.

### ACADEMY MEDAL FOR IAN CHUBB

The Australian Academy of Science has awarded former Australian Chief Scientist, Professor Ian Chubb AC FTSE the Academy Medal – its highest honour for contributions to Australian science outside of research.

President of the Australian Academy of Science, Professor Andrew Holmes FAA FTSE, said the Medal was not given annually, but was awarded when an extraordinary candidate was identified.

"Professor Chubb has dedicated his life to science in Australia as our Chief Scientist, as Vice-Chancellor of the Australian National University and Flinders University, and as President of the International Alliance of Research Universities," Professor Holmes said.

"He is a champion of research who has worked tirelessly to ensure science enhances the lives of all Australians, be it through innovative technology, informed policy or a scientifically literate public."

Professor Holmes said that Professor Chubb's dedication to his numerous roles in science and education had provided opportunities for Australian scientists and researchers to flourish.

Professor Chubb was named 2011 ACT Australian of the Year.



Ian Chubb (right) receives the Academy Medal.

# ATSE PEOPLE

## Cathy Foley back at STA

Dr Cathy Foley PSM FTSE, past President of Science and Technology Australia, is rejoining the STA leadership team as Policy Chair. Dr Foley is a physicist and Science Director and Deputy Director of Manufacturing at CSIRO.

In 2015 she was awarded the Clunies Ross Medal and the Australian Institute of Physics' Outstanding Service to Physics Award. She was named 'Woman of the Year' by the NSW Government in 2013 and won the 2014 International IEEE Award for Continuing and Significant Contributions to Applied Superconductivity.

Dr Foley has made distinguished contributions to the understanding of superconducting materials and to the development of devices using



Cathy Foley and Keith Leslie shared a 2015 Clunies Ross Award.

superconductors for various applications including to detect magnetic fields and locate valuable mineral deposits.

She is Chair of the Australian National Fabrication Facility Victorian Node Collaboration Committee and the ARC Steel Hub Advisory Committee, as well as sitting on several other committees and boards.

Before her current appointment, Dr Foley was involved in CSIRO's Superconducting Devices and Applications Project, developing superconducting systems for mineral exploration, detection of metal for quality assurance in manufacturing, terahertz imaging and UXO detection. Her team was responsible

for the development and commercialisation of LANDTEM, which has led to the discovery of more than \$6 billion worth of ore deposits worldwide and earned her a Clunies Ross Medal.

She won the Eureka Prize for the Promotion of Science in 2003, in 2009 she was the recipient of both the NSW and National Telstra Women's Business Award for Innovation, and in 2011 won the AUSIMM MIOTA Prize.

She is a Fellow of the Institute of Physics in the UK, Past President of the Australian Institute of Physics, and a personally appointed member of the Prime Minister's Science, Engineering and Innovation Council. She is a member of the Questacon Advisory Board and sits on numerous advisory boards, review panels and conference organising committees.

## FELLOWS ON ARC COLLEGE OF EXPERTS

Four Fellows have been named among the 176-strong Australian Research Council (ARC) College of Experts for 2017. College members are appointed for up to a three-year term and are announced annually, ensuring a constant source of expertise. There are 58 new names on the 2017 College.

The College plays a key role in assessing research proposals for funding under the National Competitive Grants Program (NCGP) – identifying research excellence, moderating external assessments of research grant proposals and recommending projects to be funded.

The ARC College of Experts is comprised of a wide range of experienced and highly qualified people of international standing drawn from across academia, industry and public-sector research organisations.

ATSE Fellows serving on the Colleges for 2017 are:

- Professor Rose Amal, University of NSW;
- Professor Jay Guo, University of Technology Sydney;
- Professor Doreen Thomas, University of Melbourne (and Chair of ATSE's Education Forum); and
- Professor Zhiguo Yuan, University of Queensland.



Dr Bronwyn Evans FTSE has been appointed ISO Vice-President (Finance) for 2017-18. Dr Evans is CEO of the ISO member in Australia, Standards Australia. Dr Evans has more than 30 years' experience as a leading business executive in the fields of medical devices, engineering education, standards development and power generation.

In 2015, she was appointed the Chair of MTP Connect, an Australian Government program aimed at

accelerating Australia's innovation and global competitiveness in medical technologies and pharmaceuticals, and appointed a Board Member of the Australia-Japan Foundation.

Dr Evans has led regional businesses across 12 countries and had global leadership responsibility in a listed company in the medical technology sector. She has also had extensive experience in engineering roles in both private and public-sector organisations, and held governance positions in Australian industry and professional associations, the Australian Government Think Tank on Future Manufacturing Industry Innovation Council, and the Warren Centre for Advanced Engineering at the University of Sydney.

She has received many awards, including the Engineers Australia President's Award, and has been acknowledged as one of Australia's 100 most influential engineers.

- ISO is a Geneva-based independent, non-governmental, international organisation with a membership of 163 national standards bodies.



Rose Amal



Doreen Thomas



Jay Guo



Zhiguo Yuan

# Graduate Research Training.



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**dream large**



THE UNIVERSITY OF  
MELBOURNE



# Creating change for people with chronic pain

Professor Maree Smith, Director of the Centre for Integrated Preclinical Drug Development at UQ

**Chronic pain can be a debilitating condition, but thanks to the perseverance of UQ pharmaceutical research, help may soon be at hand for the millions of people around the world in desperate need of respite.**

Currently, most chronic pain treatments block receptors in the brain and/or spinal cord. UQ's Professor Maree Smith has discovered a revolutionary way to alleviate neuropathic pain and potentially chronic inflammatory pain. This method targets augmented signalling by a type of peripheral nerve receptor not previously recognised as having a role in chronic pain signalling.

As a result of Professor Smith's discovery, Spinifex Pharmaceuticals was created by the UQ commercialisation arm, UniQuest. Spinifex Pharmaceuticals has now been bought by Novartis International AG, and using Professor Smith's technology, they are currently developing an oral drug that can be taken by people experiencing chronic pain.

Professor Smith is the Director of the Centre for Integrated Preclinical Drug Development in UQ's Faculty of Medicine. With three research intensive schools and four clinical research institutes and centres, the Faculty is well-positioned to tackle some of the big issues in human health. Spinifex builds on the unprecedented commercial translation achievements of UQ, including the world's first cancer vaccine, Gardasil. For more information visit [medicine.uq.edu.au](http://medicine.uq.edu.au)

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

Join more than 4000 students currently pursuing a research higher degree at UQ. Visit [graduate-school.uq.edu.au](http://graduate-school.uq.edu.au)



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