

ATSE FOCUS



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COLLABORATING WITH THE WORLD

SHARING THE KNOWLEDGE FOR AUSTRALIA'S BENEFIT

International collaboration ensures that the world's best comes to us and our best goes to the world.

CluniesRoss2016



2016 NOMINATIONS NEW FORMAT AND CATEGORIES CALL FOR NOMINATIONS

Nominations for the 2016 Clunies Ross Awards will open on Monday 3 August and will close on Friday 30 October, 2015

There will be a new format and specific categories for the Awards in 2016.

Over the past quarter of a century the Awards have recognised contributions by dedicated individuals to the application of technology for the benefit of Australia, highlighting ATSE's commitment to fostering innovation and commercialisation and acclaiming the work of those taking the nation's leading technologies to the marketplace.

In recognition of the complex nature of such activities, from 2016 the Awards will be made in three categories with a single winner in each category. The winners will be announced at **ATSE's Annual Challenge Conference in Sydney, planned for 15/16 June.**

IF YOU WISH TO NOMINATE A 2016 AWARD CANDIDATE THE RELEVANT DOCUMENTS WILL BE ON THE ATSE WEBSITE SOON.

CATEGORIES

The three award categories are:

Clunies Ross Entrepreneur of the Year Award

For those who have been responsible for the creation of a product or service with a financially successful outcome, in either an early stage or mature company environment with demonstrated impact for Australia.

Clunies Ross Knowledge Commercialisation Award

For those who have been responsible for a technology which has been commercialised, most likely by licensing, with a financially successful outcome.

Clunies Ross Innovation Award

For those who have been responsible for the adoption of a technology, at a stage where the financial outcomes are yet to be realised and/or the benefits are of a measurable broad community nature.

CRITERIA

The award criteria are:

1. The award winner has made an identifiably significant contribution to the advancement of industry and/or the community through the application of science and technology for the economic, social and environmental benefit of Australia;
2. The award winner is able to demonstrate that the impact or potential impact of the technological based innovation; and
3. The award winner has advanced the promotion of innovators and community awareness of technological innovation.

INQUIRIES clunies.ross@atse.org.au

CluniesRoss

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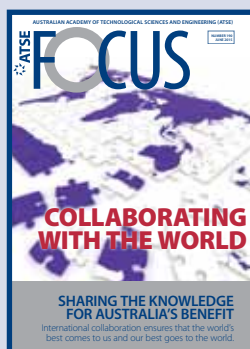
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PHOTO: 123RF.COM



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FOCUS

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

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Real Opportunity. Real Responsibility.

At Orica, we are serious about graduate development.

So serious that our Graduate Program led to Orica recently being awarded the prestigious graduate recruitment industry award, the Will Spensley Memorial Award for Innovation. The award recognised the work of our Graduate Sustainability Committee, which was launched to develop Orica graduates' leadership skills and provide a forum for graduates to make a difference to Orica and the communities we operate in. Our graduates have raised funds and volunteered for not-for-profit environmental, health and social causes in Australia, Latin America and North America.

Orica is also serious about science education. As major and founding sponsors of ATSE's hands-on, inquiry-based, in-curriculum program – the STELR Project – Orica has helped more than 360 high schools in Australia become STELR schools. Our graduates and experienced professionals alike are working with the STELR team to support the growth of this outstanding program.

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By Kaye Basford
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Using our worldwide networks to promote collaboration

Our emerging research leaders benefit from their international networks and access to major infrastructure and the latest global resources, generating new ideas and technologies.

Australia's economic competitiveness and social and environmental wellbeing depend on translating its science and technology research into industry innovation and application – a process vitally strengthened through international engagement.

International engagement is a long-term investment that builds trusted and culturally sensitive relationships, developed at the personal, institutional and diplomatic level.

ATSE's established partnership with the Australian Government and our substantial links to key research institutions, industries, government agencies and other science and technology-related organisations within the scientific community – largely through our Fellowship and their colleagues – has been a key aspect of strengthening international engagement.

The Academy has some 35 Foreign Fellows drawn from Asia-Pacific, Europe and the US. These International Fellows enable ATSE to utilise its extensive global networks and gather intelligence on a wide range of issues including new thinking in technology and innovation that can be used for Australia's benefit.

A recent example was the contribution of our Foreign Fellows in the development of ATSE's position paper on meeting the future energy needs of Australia.

ATSE is an active (and foundation) member of the International Council of Academies of Engineering and Technological Sciences (CAETS), comprising 26 engineering and applied science academies from Europe, the Asia-Pacific region and the Americas. CAETS is an effective forum for the consideration of technology-related issues of global significance and fosters valuable contributions to



Mr Jose Luis Irigoyen, from the World Bank, addresses an International Infrastructure Workshop, organised by ATSE in Melbourne.

engineering and technological progress for the benefit of all nations.

CAETS carries out work through its biennial Convocations on topics of global importance and Symposia held in conjunction with the CAETS Annual Council Meeting. CAETS Membership provides ATSE with direct linkages to influential Academies and their Fellows, enabling us to network extremely effectively. ATSE hosted the 18th CAETS Convention in Cairns and recently played a major role in establishing and advancing the work of the CAETS Committee on Energy.

Global engagement opportunities are progressed and developed through the important support provided by the Australian science and research counsellors based in overseas diplomatic posts and through foreign diplomatic missions in Australia and the Councils established by the Australian Government Department of Foreign Affairs and Trade.

These bilateral activities are implemented by Fellows participating in missions, workshops and delegations; assisting staff in the design of activities

and selection of participants; and acting as high-level contacts and hosts to foreign participants in mid-career exchange schemes.

Success is facilitated by the oversight of the Academy's International Engagement Strategy Group and our skilled and experienced staff in the international policy and project area. A recent achievement was the hosting of a delegation of young Indonesian scientists, as part of their Academy's Science Enrichment Program.

As an island country with a small population, international collaboration provides Australian experts with opportunities to participate in research activities of global and national significance and also to have influence in forums that allows Australia to help set the international agenda for research and innovation.

Partnerships with large overseas companies allow Australian small to medium enterprises (SMEs) to overcome the challenges of commercialisation in the global market.

It is essential that our emerging research leaders benefit from the

OUR INTERNATIONAL STRATEGY

ATSE's international program of missions, workshops and delegations, together with support from specific grants and schemes, is directed at strengthening Australia's access to global science, engineering and technology and to maximising the benefits of Australia's science base and its global linkages.

ATSE's five-year strategic plan focuses on:

- Targeted reciprocal missions and workshops directed towards industry sectors and aspects of applied S&T of high national priority to establish and maintain interaction between technologists in Australia and Korea, built on relationships between the Academy and similar international counterpart organisations.
- Mid-career exchange programs to establish strategic partnerships and networks to build an innovative future.
- Sourcing grants for international activities in priority areas to invest in the future internationalisation of science and technology, leading to improved competitiveness and economic benefit for Australia.

development of international networks and access to major infrastructure and the latest global resources, to generate new ideas and technologies, leading to

innovation and commercialisation.

With China alone, ATSE is working with the Chinese Academy of Engineering, Chinese Academy of Sciences, Chinese Ministry of Science and Technology and the Shanghai Association for Science and Technology to promote such interactions.

Through the activities of Topic Forums, Divisions, Working and Advisory Groups, ATSE Fellows play a vital role linking academia, research institutes, industry and SMEs to collaborate on issues of national and global importance. While Australia is strong on research excellence, we perform poorly by international standards in translating publicly funded research into commercial outcomes. We need to add value through innovative technologies and creative ideas, in order to boost commercial returns from our research and enhance Australia's economic competitiveness and social and environmental wellbeing.

ATSE and the Korean National Academy of Engineering will discuss this topic at the October 2015 Workshop to highlight models that have enhanced and impacted on the successful translation of Australia Korea research into commercial outcomes.

The Academy supports the need for a global plan to maintain Australia's competitive advantage, to drive prosperity through technological innovation through key country partnerships that will ensure Australia's global position and afford Australian research and industry

new opportunities for the future.

Such a strategy would identify targeted action priorities aligned with government and industry priorities and provide a strategic, long-term funding base to expedite solutions to Australia's research and innovation challenges.

As an example, ATSE believes the promotion of contacts among the next generation of future leaders will lead to the development of long-term substantial research/industry linkages and deliver innovation and economic benefit to Australia.

This will be progressed through a visit to Australia by eight senior Japanese researchers through the Japan Australia Science Industry Connect Program and the Australia Japan Emerging Research Leaders Exchange Program.

ATSE calls for government and industry to support new funding models that will deliver long-term, sustainable global partnerships, linking research and industry to optimise Australia's productivity.

The recent Free Trade Agreements provide key opportunities to enhance Australia's research, innovation and productivity through improving research translation and commercialisation of technology into the marketplace. For industry, especially SMEs, access to these specific markets is a vital step to realise these opportunities.

This has been demonstrated recently through ATSE's successful management of the Connecting Australian European Science and Innovation Excellence (CAESIE) Program promoting SMEs and researcher engagement (see page 22).

PROFESSOR KAYE BASFORD FTSE is Professor of Biometry at the University of Queensland, working at the interface between statistics, quantitative genetics and plant breeding. She was President of UQ's Academic Board (2012–14), Deputy President (2009–11) and Head of the School of Land, Crop and Food Sciences (2001–10). She is a member of the Board of Trustees of the International Rice Research Institute and the Board of Directors of ATSE, Grains Research Foundation Ltd, Union College and the Crawford Fund. She has been President of the International Biometric Society and the Statistical Society of Australia. She chairs the ATSE International Engagement Strategy Group.



Dr Dongwha Kum, Vice President of the National Academy of Engineering of Korea, meets with ATSE's Mr Peter Laver (right) and Dr Vaughan Beck.



By Geoff Stevens
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Our links with Japan are important to us both

Collaborations are built on personal, as well as scientific and business, relationships. Future science leaders need to build these connections and continually develop them.

Japan and Australia have a long-standing and close partnership, one that is important to both countries' strategic and economic interests.

Japan is Australia's second-largest export market and third-largest source of foreign investment, the significance of this being demonstrated with the recent Japan Australia Economic Partnership Agreement.

The two countries also have extensive research, scientific and technological interchanges, following on from the 1976 Nippon-Australia Relations Agreement (NARA) Treaty and the 1980

THE GREAT EAST JAPAN EARTHQUAKE

The 2011 earthquake and tsunami, the most powerful to hit Japan and the fourth most powerful recorded worldwide since modern record-keeping began in 1900, is known in Japan as the Great East Japan Earthquake. It triggered tsunami waves up to 40 metres to the east of Honshu Island and travelled inland up to 10 kilometres, causing some 16,000 deaths and widespread devastation and damage to nuclear reactors at Fukushima.

There was extensive and severe structural damage in north-eastern Japan, including road and rail damage, a dam collapse and widespread fires. More than four million households in this area were left without electricity and 1.5 million without water.

Japan's then Prime Minister, Mr Naoto Kan, said: "In the 65 years after the end of World War II, this is the toughest and the most difficult crisis for Japan."

Early estimates placed insured losses from the earthquake alone at up to US\$35 billion.



Ms Kathryn Fagg addresses the JASIC workshop in Tokyo in May.

Agreement on Cooperation in S&T. However, this is a relationship which needs to be strengthened further, with both countries primarily looking to the US, Europe or other Asian countries for collaboration before each other.

Japan has a strong focus on science and innovation. In 2012, Japan had the third highest investment for R&D in the world, placing fifth as a percentage of GDP. Japan's priority areas include a focus on clean and economical energy systems; a healthy and active ageing society; next-generation infrastructure; regional revitalisation/industries; and recovery from the disastrous 2011 earthquake and tsunami.

The Australian Academy of Technological Sciences and Engineering has run a number of programs on behalf of the Australian and Japanese governments, namely with their counterpart Academy – the Engineering Academy of Japan.

These initiatives have assisted in enhancing the relationships on various levels with Japan, and include the Australia Japan Emerging Research Leaders Exchange Program, allowing the future leaders of both countries to develop linkages, and the recent Japan Australia Science Innovation Connect Initiative, which is focused on research-industry linkages.

COLLOIDS

Colloid science is the study of material dispersions that rely on molecular and nano-scale phenomena to impart key properties. Such colloidal phenomena, which include adsorption, aggregation and self-assembly, are dictated by surface interactions. Colloid and surface science are thus inextricably related, and are enabling disciplines for global industries, including minerals processing, water treatment and pharmaceutical formulation. They are also key ingredients for the 'nanotechnology revolution'.

I personally have enjoyed long-standing and strong relationships with Japan, but many institutions and businesses are not reaping the benefits of bilateral partnerships.

Why Japan? How can partnerships assist with Australia's social and economic wellness? What can our two countries offer each other?

There are a number of priority areas in Japan that are closely aligned with Australia, with similar problems being shared – such as clean energy systems, infrastructure and healthy ageing. However, more than this, it is the gaps that each country has in their research and development that can be filled by the other.

For Australia, for example, the work being undertaken in colloid and interfacial science has traditionally been strong in both Australia and Japan and over a period of 30 years the Joint Australia-Japan Colloids community has developed generations of researchers who have worked together. This has led to the involvement of the Particulate Fluids Processing Centre, a Special Research Centre of the Australian Research Council at the University of Melbourne, being involved

Enhancing Australia's prosperity through technological innovation

The Australian Academy of Technological Sciences 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 energy, water, health, education, built environment and innovation – and 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 similar events to enable the Academy and its Fellows to contribute on important national issues;
- Managing the development and execution of our programs; and
- Supporting relationships with international communities.

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in two World Premier Institutes within Japan to further the development of new materials research in both countries.

This is also complemented by the different facilities and equipment which is offered in each country – for example Australia has had a long and strong involvement in Japanese Synchrotron Science, with its own beam line in the Japanese facility. Since Australia opened the Australian Synchrotron this relationship has grown to share this expensive and critical infrastructure.

In addition to this, Japan has a strong focus on international collaboration and being a leader globally. This can be seen with initiatives such as the World Premier International Research Centre Initiative – which attracts the top scientists globally. At the moment, Australia has little representation within these, which is something we should build. This would not only mean that Australia had a strong partnership with Japan, but linkages into leading research globally.

Australia needs to remember that collaborations with many countries, especially Japan, are built on personal – as well as scientific and business – relationships. It is important that the future generation of scientific leaders begin to build these connections now and have the opportunity to continually develop them.

There needs to be support for this collaboration at all levels – including researcher mobility, the encouragement of long-term fellowships to Japan, industry internships and trade missions.

The difficulty is not just about funding. Australians are not keen to spend extended times in Japan due to perceived language and cultural difficulties. Many Japanese institutions now offer courses in English and provide extensive support to international students and guests.

There are also many organisations which encourage linkages on a business level – for example the Australia Japan Business Cooperation Committee and its counterpart in Japan, the Japanese Chambers of Commerce – as Japan is such an important trading partner. The transition from Australia to Japan is now easier than at any time in the past. This could be more closely linked to science and innovation.

One difference between the two economies is that many Japanese companies will undertake R&D within the company. They may benefit further from gaining some external expertise but, more importantly, Australian researchers may gain different expertise by working closely with a company.

On top of this, the Japanese Government is investing in different types of innovation hubs and innovation clusters. One example is the Kobe Biomedical Innovation Cluster – one of the largest biomedical clusters in Japan – which consists of research institutes, highly specialised hospitals, and multiple medical companies and groups, which are involved in everything from basic research to the development of clinical applications and industrialisation.

Japan is at a similar stage to Australia in regards to university-industry linkages, with similar programs being administered (such as the Centres of Innovation, which have a similar scope to the CRCs), and there are a high number of incubators in Japan – with many universities, wards and governments owning one.

This all encourages new ideas, collaboration and innovation. If Australian researchers were more involved in this environment, there would be more acceleration of deployment of technologies, which would provide benefit to both countries. There are various focus areas where R&D would prove to be complementary.

Japan is a fascinating and exciting place that offers opportunities for collaboration in science, technology and business.

There are a range of schemes that can

JASIC ENGAGEMENT

The Japan Australia Science Industry Connect (JASIC) project proposes a pilot visit to Australia by eight Japanese mid-career to-senior researchers. ATSE has commenced discussions with potential partners in Japan and an ATSE delegation visiting Japan in May to engage stakeholders and confirm the program details. The proposed topic areas are biomedical agribusiness, energy and manufacturing. The Australian delegation was led by Ms Kathryn Fagg FTSE and included Professor Jim Patrick AO FTSE, Dr Tony Peacock, CRC Association CEO, and Professor Kazuhiro Nogita from the University of Queensland.

support involvement with collaborations in Japan and, as our second-largest export market, it is essential that we engage more deeply with Japan to ensure our long-term and successful relationship is continued, deepened and strengthened.

LAUREATE PROFESSOR GEOFF STEVENS FTSE, from the Department of Chemical and Biomolecular Engineering at The University of Melbourne, leads an internationally recognised separations group, is the Director of the Particulate Fluids Processing (PFP) Special Research Centre and a Project Leader in the CRC for greenhouse gas remediation (CO2CRC). He is Secretary General of the International Solvent Extraction Committee and his research interests are in the areas of separation processes, particularly solvent extraction, interfacial phenomena and emulsion stability. He was named in Engineers Australia's list of the 100 Most Influential Engineers for 2010. He has supported many ATSE international initiatives.

KEY PARTNERS

The Engineering Academy of Japan (EAJ) provides ATSE with a close avenue for engagement. Since 2002, EAJ and ATSE have organised several strategic initiatives together, including the Australian Japan Emerging Research Leaders Exchange Program (ERLEP), which has seen 24 Japanese mid-career researchers travel to Australia (2010, 2012, 2014) and 24 Australian researchers visit Japan (2010, 2013, 2014). This initiative has been funded by the Australian Government and the Japan Society for the Promotion of Science (JSPS).

The Australia-Japan Foundation (AJF), established by the Australian Government in 1976 to expand and develop contact and exchange between the peoples of Australia and Japan, has been a valuable supporter to progress Australian Japan S&T linkages. The AJF will be supporting the next round of the ERLEP exchange along with the Department of Industry and Science, for Japanese researchers to visit Australia in October 2015.

By Aibing Yu
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China and Australia are natural partners

Australia–China science and research collaboration between has expanded significantly in the past two decades, from individual to team, institutional and national levels.

Science and research collaboration is an important part of the relationship between countries and is a consistently positive area of bilateral relations. This certainly applies to the relationship between Australia and China.

In addition to its well-known and rapidly growing economic and industrial strength, China has become a major global power in innovation, science and research. China is now in the top three countries in all major indicators of science and innovation strength, and is rapidly increasing its relative share globally.

The scale and quality of China's research makes it a priority partner for science and research collaboration for all major scientific nations today. Australia enjoys a long-standing reputation for high-quality science and outstanding innovation, with one of the highest per capita rates of scientific publications in the world, and an impressive history of world-leading inventions and discoveries.

It is a natural research partner for China, particularly in areas of mutual strength and common priority.

Publication collaborations between Australian and Chinese co-authors have increased much faster than between Australia and other countries. China has been Australia's third partner for some years and will overtake the UK to be the second within a couple of years (see Figure 1).

Interestingly, there seems limited competition here, because the top areas for collaboration differ: engineering, physics, materials science, chemistry and computer science for Australia-China collaboration; and astronomy, physics, biology, neurology and environmental sciences for Australia-US and Australia-UK collaboration

The scale of science and research collaboration between Australia and China has expanded significantly in the past two decades, evolving from research individual to team and then

to institutional and national levels.

This trend can be demonstrated by a few representative examples, in addition to the well-established collaborative activities at the national level – such as those through the International Science Linkage scheme or the bilateral symposium series organised by the Australian Academy of Technological Sciences and Engineering (ATSE) and other learned academies.

First, more and more joint research centres between universities in Australia and China have been established. Among these centres, the most representative would be the Baosteel-Australia Joint Research and Development Centre (www.bajc.org.au). Funded by Baosteel (China) – one of the most advanced steelworks in the world – it involves four Australian universities: the University of Queensland, the University of NSW, Monash University and the University of Wollongong.

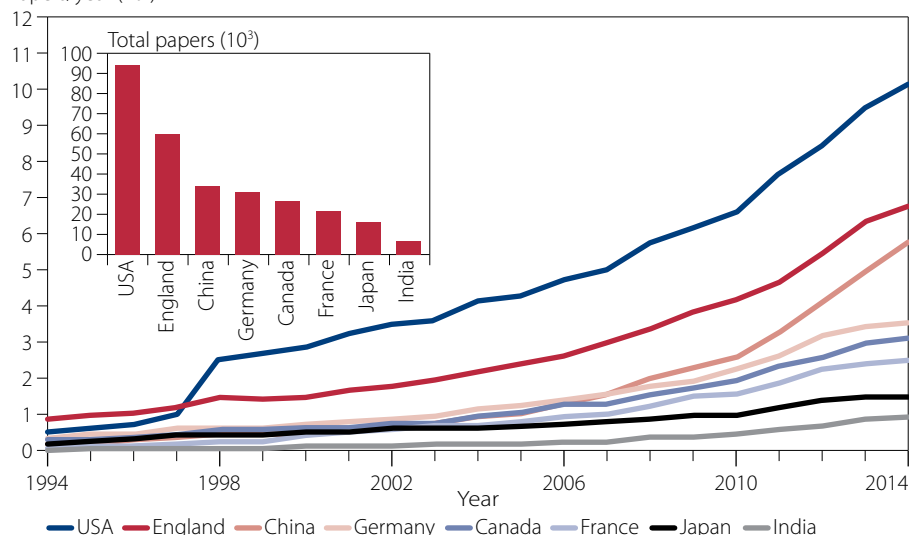
Secondly, together with the Chinese Government, the Australian Government, through its Australia-China Science and Research Fund (ACSRF), has established six Australia-China Joint Research Centres, each involving tens of researchers from leading R&D organisations in Australia and China, in order to better support collaboration in environmental science, energy, sustainable futures, agriculture and biological sciences, engineering and materials science (see www.science.gov.au/international/CollaborativeOpportunities/ACSRF/Pages/default.aspx).

Under the new agreement between the Australian and Chinese governments, the ACSR scheme will continue, meaning more Australia-China Joint Research Centres will be established in the next few years, although the funding level is the same.

How does such a joint centre

Figure 1 Number of joint publications between Australia and major countries 1994–2014.

Papers/year (10^3)



SOURCE: ISI WEB OF SCIENCE

OUR CHINA LINKS

Since the 1980s ATSE has maintained strong linkages with China through the Ministry of Science and Technology (MOST). Recent activities with MOST have included the very successful Australia China Young Scientist Exchange Scheme, which was established in 2006 and involves a two-week exchange visit program between Australian and Chinese Young Scientists.

In March 1998 ATSE signed a Memorandum of Understanding with the Chinese Academy of Engineering (CAE), China's foremost academic and advisory institution in engineering and technological science, resulting in a strategic program of joint missions and workshops, focusing on energy, ICT and minerals processing. The President of Chinese Academy of Engineering, Professor Zhou Ji, is a Foreign Fellow of ATSE.

The Chinese Academy of Sciences (CAS) is China's leading academic research agency, with more than 100 scientific research institutions focusing on natural science, technological science and high-tech innovation. ATSE and CAS signed a MoU to facilitate S&T cooperation between the two Academies in September 2008. Professor Li Jinghai, the Vice President of CAS, is a Foreign Fellow of ATSE.

Since 2004 ATSE and the Australian Academy of Science, on behalf of the Australian Government, have organised the Australian China Symposia Series, attended by the Presidents of CAS, AAS and ATSE.

The Australian Government invited ATSE to manage the Australia-China Joint coordination Group (JCG) Partnership Fund for a range of activities that support the ongoing collaboration between Australia and China in low-emission coal technology (LECT). ATSE has liaised with a range of Chinese partners, including China's Huaneng Energy Research Institute (CERI), with which it has an MOU.

ATSE has been working since 2004 with the Shanghai Association for S&T (SAST), a non-government and not for profit organisation which is the largest scientific institution in natural science and technology in engineering in Shanghai, more than 220,000 individual members.



Julia Gillard, the then Prime Minister, and the Co-Directors of the six funded Australia-China Joint Research Centres at the opening ceremony in Beijing in 2013.

function? The Australia-China Joint Research Centre for Minerals, Metallurgy and Materials is an example.

The Centre was established in 2013, aiming to provide a platform to foster interdisciplinary collaborations between Australia and China to meet the challenges in the minerals, metallurgy and materials industries. Its collaborations include collaborative research for developing innovative processes or products; training young engineers and scientists; application and commercialisation of research outcomes; academia and industrial linkages for knowledge and technology transfer; and formulation of informative and strategic advice for the development of government policies.

The operation of this centre during the two-year funding period is quite successful:

- 1** More than 100 Australian researchers – about half junior researchers (below associate professor level) – visited more than 150 universities/institutes/companies in China.
- 2** Several Australia-China joint symposia were held in Australia or China, leading to the publication of a few special issues in internationally learned journals.
- 3** Some new and significant collaborative projects or initiatives have been developed, including the ARC Industrial Transformation Hub for Computational Particle Technology, sponsored by leading Australian and Chinese industries such

as Rio Tinto, Baosteel and Longking.

Clearly, such a centre not only facilitates the economic development and environmental improvement but also strengthens the relationship between the two countries. With limited funding, it can support a large number of researchers to develop and/or conduct collaborative research and is very cost-effective.

Research training is closely associated with research itself.

Australia is a leading global education powerhouse, providing local and international students with a wide range of quality study options. Not surprisingly, education has become one of Australia's largest export sectors, contributing significantly to the Australian economy.

More students come to Australia from China than from any other country and Australia and China have already benefited from strong collaboration in education and research training. The latter is an important component to foster science and research collaboration.

Australian universities have already developed many ways to work with their Chinese counterparts in training higher degree research students. Such joint training enhances joint research and publication between Australian and Chinese academia, beneficial to both countries in the long run.

Notably, treating it as an important strategy for internationalisation,



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

What is the API?

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

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

Value Proposition

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

The key objectives of API are to achieve the following:

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

Further Information

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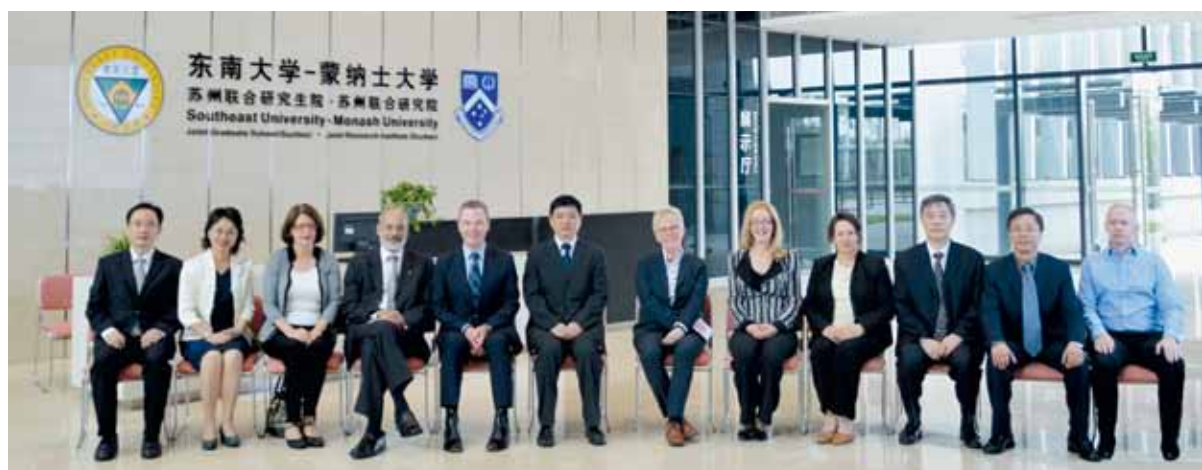


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www.api.edu.au and www.powerengineering.org.au





Education Minister Christopher Pyne's delegation visited the Monash–Southeast University Joint Venture in 2014.

Monash University has gone farther, successfully becoming the first Australian university to receive a licence to operate in China. Its collaboration with Southeast University (SEU) – one of China's key national universities – will graduate masters and PhD students.

The Monash–SEU partnership aims to establish a world-class research and training institute in Suzhou, with targeted enrolments being about 1500, including 1000 masters and 500 PhD students, by 2019. This joint venue will attract outstanding researchers and high-calibre research students, building up a critical mass of researchers to strengthen relationships in R&D with local and global companies and institutions.

It should significantly add value to the science and research collaboration, not only between Monash and Southeast Universities but also between Australia and China.

For example, it can play a very useful role in expanding less developed channels of collaboration, such as commercialisation of research outcomes, thereby boosting the innovative capability of both countries and leading the transformation of industries, economies and societies for a sustainable future.

It is likely more such collaborations will be developed between Australia and Chinese universities. The University

of Queensland and Jilin University are working together in this direction already.

We have seen the significant changes in the international research and innovation landscape in the past decades. These changes are necessary in order to better address the global challenges in food security, resource constraints, energy security, climate change and increasing urbanisation.

International collaboration plays a very important role in strengthening capacity and impact, meeting costs of critical infrastructure and addressing complex and long-term strategic challenges. Collaboration in science and research can bring benefits well beyond the academic sphere, with improved cross-cultural understanding, personal and institutional linkages, and increased capacity of economies to absorb and utilise innovations from abroad.

Such benefits are obvious in the collaboration between Australia and China. Australia and China face considerable challenges in securing their future value proposition and sustaining a competitive advantage in a carbon- and resource-constrained world.

But a high level of complementarity exists between Australia and China. For example, Australia is a key supplier of resources, food, services and education which China requires. In turn, China

is a major exporter of manufactured products that Australia requires and, in the meantime, has a huge market for commercialising new technologies and products developed in Australia.

China's complementarity with Australia's net import requirements is considerable, representing over half Australia's total net imports, which can be enhanced with the approval of the Australia-China Free Trade Agreement.

With such a big picture in mind, there is no reason why the two countries cannot work together to find better solutions to meet their respective but complementary challenges for a better future.

PROFESSOR AIBING YU FAA FTSE is Vice-Chancellor's Professorial Fellow, Pro Vice-Chancellor and President of the Monash–Southeast University Joint Research Institute, Monash University, after 22 years with the University of NSW. He was Inaugural Director of the UNSW Centre for Simulation and Modelling of Particulate Systems, Deputy Director of the ARC Centre of Excellence for Functional Nanomaterials, Founding Director of the Australia-China Joint Research Centre for Minerals, Metallurgy and Materials, and ARC Research Hub for Computational Particle Technology, and Chair, Technical Advisory Committee of Baosteel–Australian Universities Joint R&D Centre. His awards include UNSW Scientia Professorship, ARC Federation Fellowship, NSW Scientist of the Year and Ian Wark Medal and Lecture.

LETTERS TO THE EDITOR

ATSE Focus welcomes letters from readers in response to published article or on technological science and related topics.

PLEASE KEEP LETTERS BRIEF. LONGER LETTERS MAY BE RUN AS CONTRIBUTED ARTICLES.

Please address to editor@atse.org.au

By Peter Coleman
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Australia and Korea: strong partnerships

Korea is Australia's third-largest source of international students, second-largest group of working holiday-makers and eighth-largest market of inbound tourists.

Australia and the Republic of Korea have forged strong partnerships over many years in the fields of science, technology and engineering. We now have a great opportunity to build on this foundation and boost the economic benefits that flow to both countries.

Leaders across industries in both countries rightly recognise the enduring benefits – to our companies, our nations and our people – of the relationships and the partnerships they support.

We have a good framework in place – we've successfully concluded the Korea-Australia Free Trade Agreement and this aligns with Korean President Park's Three Year Plan for Economic Innovation.

As a starting point, our two countries already enjoy extensive people-to-people and institutional links. According to the Department of Foreign Affairs and Trade, Australia is home to more than 88,000 people of Korean descent. Korea is Australia's third-largest source of international students, second-largest group of working holiday-makers and eighth-largest market of inbound tourists.

Korea has the potential to become a major research partner for Australia, particularly as Korea focuses on innovation to drive its economic growth. There is scope to increase collaboration, particularly in connecting Australia's strength in basic research with Korea's expertise in applied research and commercialised innovation.

ATSE is working to develop new collaborations to improve and broaden Australia's scientific, engineering and technological strengths through:

- holding strategic workshops exchanging technical information and identification of collaborative partnerships;
- providing Australian researchers with the opportunity to collaborate with international science



Guests attend the naming ceremony for the LNG carrier Woodside Goode at the Daewoo Shipbuilding and Marine Engineering yard in Okpo, South Korea.

and technology leaders;

- organising missions from industry, academia and government to develop new strategic alliances; and
- organising visits to leading universities and industry to build technological innovation for the benefit of Australia.

All of these are important, practical initiatives. We need to grow these contacts for the next generation of leaders in science, engineering and technology.

I encourage those companies who have not been in Korea before to consider new partnerships.

The Woodside experience

Woodside's achievements through partnership over 20 years in the LNG sector hint at the promise of what the future holds. By increasing collaboration in science, technology and engineering, we're securing Australia and Korea's economic future.

Woodside (Australia's largest independent oil and gas company) has invested more than US\$2 billion over two decades in contracts with the three

major Korean shipyards, who have played a key role in manufacturing our LNG facilities and carriers.

The development of these state-of-the-art facilities and carriers has resulted in the creation of thousands of jobs in Australia and Korea. Ultimately, it has ensured the safe, efficient and reliable delivery of LNG to Asia.

Korea is a significant customer of LNG from Woodside-operated facilities. The North West Shelf Project has been supplying LNG to Korea since 1993. Just last year, Woodside signed an agreement with Korea Gas Corporation (KOGAS) to supply up to 2.2 million tonnes of LNG over a three-year period.

More broadly, our partnerships have contributed to the viability and sustainability of Australia's LNG industry and cemented Korea's place as a world-class heavy manufacturing player.

In short, our science, technology and engineering partnership with Korea on LNG facilities and carriers has been a win-win for Korea and Australia.

An important example of this

collaboration at work will be the proposed Browse floating LNG (FLNG) project.

The world-class Browse gas resources are located more than 400 kilometres off the coast of Western Australia. In September 2013, the Browse Joint Venture participants selected FLNG in conjunction with a subsea development as the preferred development concept, marking the start of the basis of design phase.

FLNG provides a technically innovative solution to developing the remote, offshore fields. It combines the functions of an offshore gas receiving facility, with gas treatment and liquefaction plant, as well as storage and offloading facilities.

This development concept is premised on three FLNG facilities located in Australian waters, using Shell's FLNG technology and Woodside's offshore development expertise. A final investment decision, anticipated by Woodside in 2016, will enable the three FLNG facilities to be constructed in Korea at the Samsung Heavy Industries shipyard.

Browse is expected to not only make a significant contribution to the Korean economy, but also to the Australian economy.

In Western Australia, during the five-

year construction phase, it is estimated that 1000 Australian jobs will be sustained each year. Over the 40-to-50-year operations phase, it is estimated more than 1100 personnel will be sustained per year to operate and maintain three FLNG facilities.

Again, this proposed collaboration will be a win-win for both countries.

Woodside is building on its foundation with Korea through a number of other science, technology and engineering projects.

In collaboration with the Korean shipyards, we're working on a range of innovative solutions for the oil and gas industry. A great example is near-shore float-in technology, where we can build an LNG plant at a cheaper cost with reduced environmental footprint.

Over the years, our company has benefitted from innovative engineering solutions borne out of exchange programs between Korean and Australian universities. Right now we're particularly interested in research on cost-effective LNG plants of the future being developed through links between WA's Curtin University and Korea's Busan University.

Woodside has also benefited from

a technology exchange with KOGAS. We have jointly studied the application of KOGAS's membrane LNG tank for service in Australia where it has potential to provide a competitive alternative to traditional full containment systems.

These engineering links have proved invaluable and we look forward to collaborating with Korean companies on many more innovation projects in the future.

There is no doubt that Woodside is just one of many practical examples of where an Australian company has built – or is building – strong ties with Korea in science, technology and engineering.

MR PETER COLEMAN FTSE has 30 years' experience in the global oil and gas industry, and has been Managing Director and Chief Executive Officer of Woodside since joining the company in May 2011. He began his career with Exxon Mobil following graduation from Monash University and stayed with the company until joining Woodside. He is Chairman of the Australia Korea Foundation and adviser to the Asia Society. He is also a member of the UWA Business School Board and the Executive Committee of the Australia Japan Business Cooperation Council. He is an Adjunct Professor in Corporate Strategy at UWA.

Key activities with Korea

Australia and Korea are major trading partners with substantial commercial, scientific and technological interchanges. The Academy's general strategy in international initiatives is to use high-level established links where possible, while building new collaborations to improve and broaden Australia's scientific, engineering and technological strengths.

ATSE believes the promotion of contacts among the next generation of leaders in science, engineering and technology will lead to the development of long-term substantial cooperation between Australia and Korea, to deliver industry and economic benefit to Australia. ATSE works closely with key bodies in Korea to achieve closer involvement and impact.

NAEK

Our linkages with the National Academy of Engineering of Korea (NAEK) have provided an effective avenue for closer involvement. Since 2010, ATSE has undertaken four joint Workshops with Korea focusing on the topic of 'Green Growth'. These workshops were administered by ATSE and NAEK. The workshops have been supported by the Australian Government through the Australia-Korea Foundation (AKF), and the Australian Embassy in Seoul, complimented by technical site visits and networking opportunities.

KOSEF and NRF

ATSE has had a Memorandum of Understanding with the Korean Science and Engineering Foundation (KOSEF) that has resulted in 20 workshops and 13 delegations in areas including manufacturing technologies, nanotechnology and biotechnology, light alloys, ICT, polymers and ceramics. KOSEF amalgamated with the National Research Foundation of Korea (NRF) in 2010. ATSE has worked with NRF and co-administered the Australia Korea Emerging Research Leaders Exchange Program (ERLEP), with the first exchange enabling six Korean mid-career researchers to undertake a two week visit to Australia in August 2014 – reciprocated by six Australian mid-career researchers who travelled to Korea in May 2015.

Australian researchers and NRF staff at the orientation session at the Korean NRF in May 2015.



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**ATSE
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By Tam Sridhar and Mohan Krishnamoorthy

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Australia–India S&T collaboration has accelerated recently

We have a platform of significant progress in the past decade and the coming decade could well signal a golden age for the Australia–India relationship.

India and Australia have a long and shared history in the Commonwealth. One would have expected close ties and a strategic engagement in trade and scientific collaboration, but the reality, until recently, is one of sporadic engagement.

The perception in the two countries of each other has been less than healthy. The bilateral political climate has consistently overshadowed support for scientific collaboration.

The suspicion of the White Australia Policy still lingers in some quarters in India, even after nearly 50 years. This was especially displayed after the tragic attacks on Indian students in Melbourne.

The strident Australian stand after the Indian nuclear tests may have also contributed to this climate. The Indian Government lamented the lack of appreciation in Australia of the special security situation prevailing in India. As a result, despite several Australian Prime Ministers visiting India, there was no reciprocal visit from an Indian Prime Minister until 2014.

As a result the bilateral relation in science and technology (S&T) was not given adequate prominence until recently.

The convergence of politics and collaboration was signalled during the visit of Prime Minister John Howard in 2006 and heralded a new era in collaboration and recent progress has been remarkable.

Collaboration drivers

Two-way trade between Australia and India has grown substantially from \$3.3 billion in 2000 to more than \$20 billion in 2011 but remains narrowly based, primarily on coal, gold and copper.

Last year, negotiations were formally launched to conclude a Comprehensive Economic Cooperation Agreement between Australia and India – set to broaden the relationship and deliver more than \$43 billion in real GDP and \$33 billion in real consumption to the Australian economy over 20 years.

The economic gains are substantial. Trade in commodities, especially in the light of the downturn in China, always excites the national attention. But there are other developments that should attract Australia's attention as they deliver longer-term benefits.

India is fast emerging as a major centre for cutting-edge R&D for global multinationals as well as Indian firms.

More and more companies in industries ranging from IT and telecommunications through pharmaceuticals and biotech are setting up ambitious R&D projects in India. In part, these have been set up with a view to serving the Indian market, but also with an eye to delivering new generations of products faster to the global market.

R&D expenditures in India by overseas companies has shown a massive increase from Rupees 2860 million in 2002-03 to Rupees 28,830 million in 2009-10 (some \$570 million). The share of foreign companies in the total R&D expenditure in the country has risen to around 20 per cent.

More than 800 global/multinational companies base their R&D facilities in India and for many India is their largest research centre outside the US/Europe. India is currently drawing 25 per cent of global R&D investments and is climbing up the value chain of sophisticated research.

Today 60 per cent of the world's leading product/OEM companies are sourcing part of their technology needs from India and 30 per cent of the top 1000 R&D spenders have a presence in India. India also has the highest number of US FDA-approved production facilities in the world.

Over the next decade, India's R&D sector is expected to undergo major changes as the Indian Government scales up public investments into S&T. The recent successful Mars mission showcased India's ability in technological projects of massive scale and has attracted international attention. Both Australia and India are also ramping up their defence expenditure. India's rapidly changing R&D sector will create new opportunities for Australia as it seeks to advance

KEY ALLIES

ATSE began exploring the possibility of closer cooperation with the Indian National Academy of Engineering (INAE) in 1996, signing a Memorandum of Understanding (MOU) between the two Academies in 1997. ATSE and INAE are currently seeking funds to undertake a foresighting exercise that will look at strategies to replace fossil fuels with zero-emissions electricity and alternative liquid or gaseous fuels.

ATSE undertook a key project with the Australia India Institute (All), running a task force on *Science Technology Innovation: Australia and India*, one of several high-level project groups established by the Australia India Institute providing recommendations to governments and policy makers for further initiatives to stimulate collaboration and innovation between Australia and India. The report was launched in Australia in May 2013, and an updated version was launched in January 2015 in India.

PHOTO: iSTOCK.COM



Chemistry studies in India.

its strategic relationship with India. Education, research and innovation present an important vehicle in which Australia and India can create a collaborative innovation-based partnership.

Unfortunately, this is happening precisely when the Australian Government's support for research in universities and CSIRO lacks clarity and focus, so it is not surprising that Australian researchers have sought out collaborations with Indian counterparts. Over the past decade, research collaborations between Australian and Indian researchers have been growing exponentially. Australian share of joint research papers with India has more than doubled within a decade.

Underneath all these optimistic projections, there are significant hurdles to establishing a thriving collaboration. Understanding the culture of India and the inability of projects to be completed in a time-bound manner is a challenge for Australian institutions. There are also negative perceptions about IP issues.

Changing times

On a brighter note, the changing political climate, coupled with the growth in R&D in India, led to the establishment of the Australia-India Strategic Research Fund (AISRF) in 2006. It offers an exciting opportunity for Australia to engage actively with India in an innovation-based partnership – a partnership that India also stands to gain from.

This requires placing a value on international research collaborations as fundamental to both countries' bilateral agenda. AISRF is Australia's largest bilateral program. Over the past 10 years more than \$60 million has been invested in the AISRF and recently it has been extended for another five years.

AISRF is considered an important part of Australia's diplomacy in India and a flagship program of the Department of Foreign Affairs and Trade (DFAT).

There has been a change in emphasis in universities from a focus on undergraduate student recruitment to research collaboration. Perhaps Professor Richard Larkins, AO FTSE, former Vice Chancellor of Monash University, best articulated the advantages of such a shift, saying in his recent book (see review, page 38) that "the real value of an international campus comes when it becomes research intensive and able to attract the brightest researchers and students, form partnerships with local institutions and industry and access local sources of research funding".

Professor Larkins helped establish the IITB-Monash Research Academy, which now has more than 175 PhD students enrolled and has already graduated nearly 30 students. It has ties with some of the well-known Indian, multinational and Australian industries.

The Monash experience suggests that the scale of operation is extremely important to create local awareness and

support. Small bilateral collaborations while yielding good science tend to stay below the national radar and may not be sustainable. Strong cross-institutional links are essential to develop a long lasting partnership.

To date there are a number of Australia-India partnerships: the IITB-Monash Research Academy; the TERI-Deakin Research Centre (Deakin University and The Energy Research Institute); the IICT-RMIT Research Centre (the Indian Institute of Chemical Technology and RMIT University); CSIRO and the Council of Scientific and Industrial Research (CSIR).

Future prospects

It is interesting to speculate on the future global trends and to examine the opportunities for Australia-India collaboration from this perspective.

In McKinsey and Company's *No Ordinary Disruption: The Four Global Forces Breaking All the Trends*, the authors warn of disruptive forces that will fashion growth. These are rapid urbanisation, accelerated technological change, ageing population and globalisation.

India is projecting a migration of 300 million people from rural areas to the cities in perhaps the largest migration in peacetime. This will need the construction of 100 new cities with entire new infrastructure, with obvious implication for a resource-rich country like Australia.

Innovating for rapid technological change also requires low-cost market entry for new technologies so that the cost of failure is minimised. India offers a wonderful platform for this purpose. Recognising this advantage, several US venture capital funds are now supporting businesses in India.

In a small country with significant demographic issues looming, it is imperative that Australia does not lose to opportunity to capitalise on this decade of progress and further strengthen its collaboration with Indian scientists and institutions and seize the opportunities.

We have a platform of significant progress in the past decade and are ahead of most other countries.



By John Radcliffe

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Taiwan and Australia have strong science links

Taiwan's higher education is directed towards the needs of its high-technology industry, in which science and engineering graduates comprise more than 70 per cent of all PhD students.

Taiwan has a population of 23 million, very similar to that of Australia, in an area of less than 0.5 per cent of that of Australia. The science links between the two countries are less well known than our links with China, yet Taiwan has developed a distinctive set of science institutions since it has been governed separately.

From the early 1950s, the island developed many links with scientists in North America and especially the US, and those links remain strong. The generation of academics trained largely in the US from the 1960s onwards are now retiring and being replaced by a cohort with a broader geographical experience.

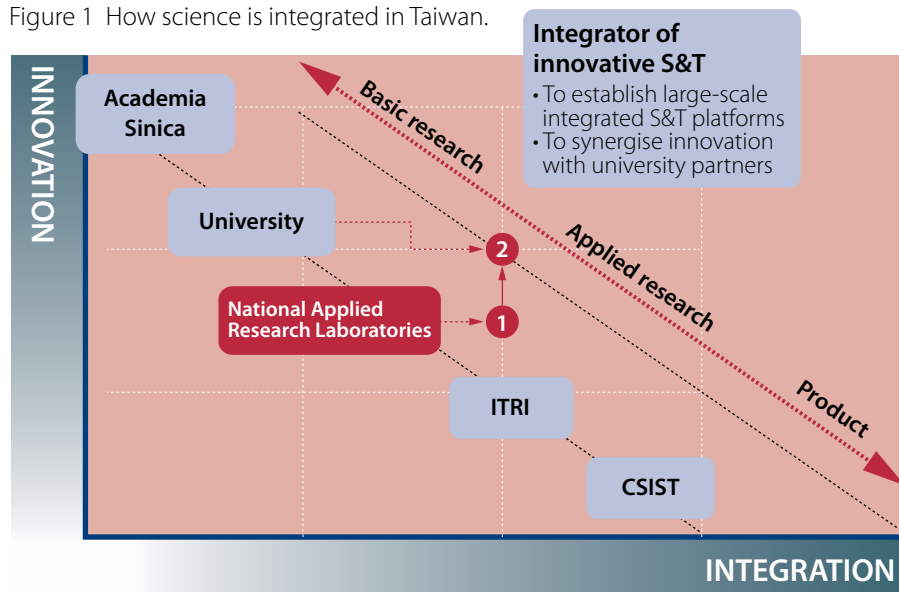
For many years, direct science links were not able to be continued with colleagues on the mainland and there were no direct transport connections, but that has now changed and academic relationships can be readily maintained.

Furthermore, Taiwan's capacity for science-based innovation has led to significant capital investment into mainland provinces.

Compared to the People's Republic of China, Taiwan has a relatively small economy and access to minimal natural resources. Successive Taiwanese governments have developed their policies to expand technological development in coordination with industrial upgrading and high-technology progress.

Taiwan's governmental science policy unit has been the Taiwan Science Council, whose origins date back to 1959. In 2014, this was elevated to become the

Figure 1 How science is integrated in Taiwan.



SOURCE: NATIONAL APPLIED RESEARCH LABORATORIES (NARL)

Ministry of Science and Technology with a budget equivalent to A\$1.7 billion. The expenditure was invested in its 13 science parks (eight per cent), national science and technology development (12.5 per cent) and research support (79.5 per cent). The A\$1.3 billion for research support was divided among education (three per cent), natural sciences (18.5 per cent), engineering and applied sciences (27.8 per cent) life sciences, medicine and agriculture (14 per cent) and other categories (six per cent).

Taiwan's higher education is strategically directed towards the needs of its high-technology industry, in which science and engineering graduates make up more than 70 per cent of the total in PhD programs.

The structure of Taiwan's science

and technology is shown in Figure 1.

Academia Sinica is the most pre-eminent academic institution in Taiwan. It was originally founded in 1928 to undertake research in sciences and humanities. It was re-established in Taipei after 1949. Academia Sinica has promoted the internal integration of research activities in the three research disciplines of mathematics and physical sciences, life sciences, and humanities and social sciences, which between them have more than 30 research institutes.

Through the 1980s and 1990s, the Government encouraged R&D in higher education, resulting in an increase in the number of tertiary institutions to more than 160. Today, nearly 70 per cent of Taiwan's 18 to 22-year-olds

CONTRIBUTIONS
ARE WELCOME

Opinion pieces on technological science and related topics, preferably between 600 and 1400 words, will be considered for publication.

They must list the full name of the author, if a Fellow of the Academy. Other contributors should provide their full name, title/role and organisation (if relevant) and email address.

Please address to editor@atse.org.au



Professor Tsair-Fuh Lin, from National Cheng Kung University, and the Academy's Dr Tom Connor co-chairing a roundtable at the Taiwan-Australia Strategic Workshop on Sustainable Water Management in 2011.

ATSE has been interacting with Taiwan's National Science Council since 1992, and has been linked in a dozen delegations and visits including at Ministerial level, the most recent being by the Minister of Science and Technology in October 2014. The Minister, Dr San-Cheng Chan, now Deputy Prime Minister, expressed the wish that more science and technology collaborations blossom between Taiwan and Australia. These visits and science interactions within Australia are facilitated by the Science and Technology Division within the Taipei Economic & Cultural Office in Canberra (TECO).

There have been a number of research linkage opportunities explored over the years including workshops in energy, nano-biotechnology, food biotechnology, non-linear analysis, joint materials processing technology, fisheries management and aquaculture, gerontechnology, and water policies and the impact of global climate change on the water industry.

Visitors have reviewed the Australian Synchrotron, the Centre for Green Chemistry, and the Australian Genome Research Facility. The Asia Pacific Water Recycling, Membranes and Desalination Conference in Brisbane, in July 2013, included an invited presentation by Distinguished Professor Pen-Chi Chiang, Graduate Institute of Environmental Engineering, National Taiwan University.

Taiwan has significant science and technology resources that are well-linked internationally but can be sometimes overlooked by Australians. Taiwanese universities have noted that relatively few students seek to undertake higher degrees in Taiwan, although many Australian universities have MoUs with Taiwan counterparts. Taiwan's strong skill base provides opportunities for enhancing our international links and collaborations.

DR JOHN RADCLIFFE AM FTSE, a former Director-General of Agriculture (South Australia), former Deputy Chief Executive of CSIRO and former National Water Commissioner, is a former Chairman of the Academy's Water Forum.

study in a higher education institution, suggested to be the second-highest rate in world after South Korea.

Seeking to internationalise its research universities, Taiwan initiated its Research Excellence initiative from 2005, aimed at enhancing the international visibility of Taiwan higher education by developing at least one university that would reach the world's top 100 universities within 10 years and 10 outstanding research centres or fields in the Asian top 50 within five years.

The number of recognised elite universities has reached 11. National Taiwan University claimed the achievement of being the top university in the Chinese-speaking world (Taiwan, China, Hong Kong, Macau and Singapore) in the 2012 Shanghai-Jiao Tong Academic Ranking of World Universities, while six Taiwan universities were listed in the top 500 for 2014.

The National Applied Research Laboratories (NARL) is a non-profit organisation established in 2003, comprising research laboratories headquartered in Taipei, but with locations also in Hsinchu, Taichung and Tainan. Its primary fields of interest include earthquake engineering, laboratory animals, disaster reduction, ocean research, nano-devices, space organisation, high-performance computing, a chip implementation centre, instrument technology, and typhoon and flood research – together with a science and technology policy research and information centre.

The Taiwan Industrial Technology Research Institute (ITRI) is a non-profit R&D organisation established in 1973 for applied research and technical services.

ITRI has underpinned Taiwan's economic growth as it shifted from a labour-intensive industry into a value-added, technology-driven one, and has played a particularly significant role in nurturing its semiconductor industry. Current interests include biomedical research, green energy and environmental research, electronics and optoelectronics, measurement standards, cloud computing, systems research, computational intelligence research and industrial economics.

It had 159 collaborative projects with companies and institutes overseas in 2013 and maintains regional offices in San Jose, Tokyo, Berlin, Moscow and Eindhoven. With nearly 6000 employees, ITRI is in many ways comparable to Australia's CSIRO.

The specialist Chungshan Institute of Science and Technology (CSIST) is responsible for the research, development, and design of defence technology in Taiwan.

Synergies where Australia has sciences complementary to the needs of Taiwan include environmental management and water resources. Taiwan can be afflicted by drought as water from short, high-intensity rainfall events, including typhoons, result in massive erosion with turbidity, rendering it unusable and dams threatened by siltation. Hence some high-rainfall areas of Taiwan are faced with a shortage of accessible, high-quality water.

The University of Adelaide, for example, has been running a joint water recycling program with National Cheng Kung University, Tainan, and the China Steel Company in Kaohsiung due to the paucity of water for the steel industry.



By Adam Finch, Tom Spurling and John Webb

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Indonesia provides opportunities for Australian collaboration

Technical assistance from Australia began with a focus on agricultural sciences but soon widened to include other fields such as economics, demography and other sciences.

Australia and Indonesia are countries of great contrasts – Australia is a vast, sparsely populated country whereas Indonesia, also vast, has the world's fourth-largest population, with an exceptionally high density of 940 people per square kilometre on the island of Java.

Scientifically, the two countries differ significantly in their scientific output and relative contribution to world scientific literature.

Over the period 2005–14, both countries saw their contribution to world publications output rise: from 2.7 to 3.6 per cent for Australia and from 0.06 to 0.16 per cent for Indonesia; Indonesia's ranking in this period rose noticeably from 65 to 57, while Australia's ranking slipped slightly from 10 to 11 (Table 1).

For Australia, the bilateral relationship with Indonesia remains one of its most important.

The history of Australia–Indonesia relations since Indonesia's independence in 1949 is complex, with significant differences as well as major collaborations emerging over this period.

Today, Indonesia is Australia's 12th largest trading partner, the seventh largest source country for international students (13,300 in 2013) and Australia's largest development cooperation partner. This bilateral cooperation has included much that has strengthened Indonesia's capacity in education, science and technology.

This strong education relationship has been sustained from the early days of the Colombo Plan. As Daniel Oakman wrote in 2010: "...in 1957 almost 500 Indonesians were attending Australian educational institutions, or had completed their studies and returned home – the highest of any Colombo Plan nation supported by Australia. By 1970, that total approached 1500."

Table 1 Australia and Indonesia: comparative data.

	Population (million) and (rank)	Population density (/km ²) and (rank) GDP	GDP rank 2014	Output of publications		Contribution to world output	
				Rank 2005	Rank 2014	% 2005	% 2014
Australia	23.8 (52)	3.1 (234)	12	10	11	2.7	3.6
Indonesia	255.7 (4)	132 (28)	16	65	57	0.06	0.16

OUR INDONESIAN LINKS

ATSE has had a Memorandum of Understanding with the Indonesian Academy of Sciences (AIPI) since May 1995. The relationship has progressed through ATSE's linkages with the Australia Science and Technology Council, visits by ATSE Fellows to Indonesia, AIPI's contributions to ATSE workshops, exchanges of publications and annual reports.

ATSE and AIPI agreed in late 2013 to organise a workshop on a water policy and practices in October 2015, funded by the Australia Indonesia Centre.

A delegation of young Indonesian scientists visited Australia in November 2014, funded by the Australian Government Knowledge Sector Initiative, AIPI and the USAID. ATSE hosted the visits in Melbourne to the University of Melbourne and the Australia Indonesia Centre.

In 2014, more than 500 postgraduate Australia Awards scholarships were offered to Indonesian students to study in Australia for short-term or long-term awards. Over the period 2007 to 2014, a total of 2982 long-term awards and 1395 short-term awards were provided to Indonesia.

Technical assistance from Australia for Indonesia's universities began with a focus on agricultural sciences but soon widened to include other fields such as economics, demography and other sciences.

Five Indonesian universities were included in the initial program of support for teaching and research in animal and plant sciences, with most activities focused on three universities: Universitas Hasanuddin in Ujung Pandang, South Sulawesi; Universitas Udayana in Denpasar, Bali; and Universitas Brawijaya in Malang, East Java.

Subsequently, development

cooperation activities have included many if not all public universities, as well as some private educational institutions, both Christian and Islamic.

The postgraduate research awards and this broad-based technical assistance program has provided a network of collaboration between Australian and Indonesian researchers, particularly in universities and government research institutes, where research collaboration has developed.

The Thomson Reuters database provides data on the number of collaborative publications between Australia and other countries.

For Indonesia, there were 1576 collaborative publications, accounting for 0.349 per cent of Australian publications over the period 2005–14. Table 2 lists the top five countries for collaboration, headed by the US, plus others of interest – where Indonesia appears at a quite low ranking, 40th.

Table 2 Australia's international collaborative publications.

Rank	Country	Number of Collaborative Publications with Australia 2005–14	% of Australian publications 2005–14
1	US	60,838	13.468
2	UK	35,896	7.946
3	China	28,791	6.374
4	Germany	20,506	4.539
5	Canada	17,769	3.934
15	Singapore	5,662	1.253
17	India	4,914	1.088
21	South Korea	4,228	0.936
24	Taiwan	3,238	0.717
27	Malaysia	2,984	0.661
29	Thailand	2,784	0.616
40	INDONESIA	1,576	0.349

During this period Indonesia ranked 62nd in the world in terms of overall output, rather lower than its collaboration ranking with Australia. Thus, with output scale taken into consideration, Australia does collaborate with Indonesia slightly more than might be expected. The number of collaborative publications per year has grown steadily, from 76 in 2005 to 152 in 2010 and 279 in 2014. Indonesia is not yet a significant source of collaboration but it is

clear that collaboration is on the increase.

The fields of collaboration are also evident from the database. Table 3 indicates that the four fields with the greatest volume of collaborative publications are plant and animal sciences, social sciences, clinical medicine and environment/ecology. The first three of these are Australia's three largest fields overall.

However, as not all fields are the same size (in terms of publications), it is



Research collaboration is the key.

more important to consider how patterns of collaboration deviate from what might be expected. One way to do this is to compare the share of Indonesian–Australian publication that each field comprises with its share of global output.

The difference between the percentages of such collaborative publications and the percentage of that field as its share of world publications indicates that eight of the fields are ones in which Australia–Indonesia collaboration produces more than what would be expected from the global averages.

These are indicated in bold in the table as the areas of research that Australian–Indonesian collaboration particularly emphasises. The top of this list of eight fields is plant and animal sciences, not surprisingly given the historical emphasis in development funding to strengthen Indonesia's agriculture. The next three fields show around five per cent positive difference: environment/ecology, social sciences and immunology.

Looking in the opposite direction – those fields of enquiry where collaboration levels are well below the global average field share – the weakest fields for collaboration are clinical medicine and physics (both at –7.6 per cent) and chemistry (–5.1 per cent).

Additional insights come from interrogating the data in terms of normalised citation impact of the collaborative publications. Table 3 shows the results for fields where at least 50 collaborative publications are in the database, thus avoiding highly skewed small distributions. The data show a lot of variation, probably influenced by which partners in Australia are collaborating with which partners in Indonesia. But overall it is about the same level as Australia's quality.

Clinical medicine has the highest

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AUSTRALIA–INDIA S&T COLLABORATION HAS ACCELERATED RECENTLY

If this opportunity is understood and grasped, the coming decade could well signal a golden age for Australia–India relationship in trade and in scientific collaboration. It is hoped that the platforms built over the past 15 years will not be wasted by lack of leadership.

PROFESSOR TAM SRIDHAR OA FAA FTSE is the Sir John Monash Distinguished Professor at Monash University. He is also the Academic Vice President (China and India Initiatives). He was formerly Dean of Engineering and had pivotal role in the establishment of the IITB–Monash Research Academy in Mumbai. Professor Sridhar, a Fellow for 20 years, has an international reputation in the area of polymers/rheology. He is a Foreign

Fellow in the Indian National Science Academy and in 2014 received the Medal of the Australian Society of Rheology and was also awarded the Chemeca Medal.

PROFESSOR MOHAN KRISHNAMOORTHY is Pro Vice Chancellor (Industry Partnerships) at Monash University and Professor of Operations Research in its Mechanical and Aerospace Engineering Department. Before this, from 2008–15, he was inaugural CEO of the IITB–Monash Research Academy, a joint venture between the Indian Institute of Technology Bombay and Monash. He worked earlier as Associate Dean Research at the Monash Engineering Faculty after working with CSIRO from 1992. He has a PhD from Imperial College London and taught at the University of Kent before coming to Australia.



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citation impact, followed closely by social sciences, while the lowest citation impacts are for physics and mathematics. Overall, collaboration with Indonesia is neither improving nor worsening Australia's citation impact. Conversely, collaboration with Australia (20 per cent more cite than the global average) is greatly beneficial for Indonesian science (which overall is 10 per cent less cited than the global average).

The need for a more strategic approach to collaboration can be developed from the insights of the above analysis. As noted in the documents of the Indonesia–Australia Research Summit held in Jakarta in May 2014, the Director-General of Higher Education, Professor Dr. Djoko Santoso, expressed his wish “that cooperation and collaboration between Indonesia and Australia both get stronger. Indonesia's best researchers want to work with their counterparts”.

At the same forum, the Director of the recently established Australia Indonesia Centre, Professor Paul Ramadge, noted that “Indonesia's rapid rise in global GDP rankings is increasing the need for

Table 3 Australia and Indonesia collaborative fields of study.

Field of study (as in Essential Science Indicators)	Australian/ Indonesian collaborative publications	% Publications	Field as share of world	Difference	Normalised citation impact
Agricultural sciences	62	4.78%	2.7%	2.0%	0.86
Biology and biochemistry	22	1.70%	5.1%	–3.4%	
Chemistry	81	6.25%	11.4%	–5.1%	0.76
Clinical medicine	137	10.56%	18.2%	–7.6%	1.76
Computer science	15	1.16%	3.5%	–2.3%	
Economics & business	54	4.16%	1.8%	2.4%	0.78
Engineering	61	4.70%	8.0%	–3.3%	0.78
Environment/ecology	111	8.56%	2.8%	5.7%	1.53
Geosciences	70	5.40%	2.9%	2.5%	1.63
Immunology	85	6.55%	1.8%	4.8%	1.26
Materials science	31	2.39%	5.2%	–2.8%	
Mathematics	19	1.46%	2.9%	–1.4%	
Microbiology	17	1.31%	1.4%	–0.1%	
Molecular biology & genetics	24	1.85%	3.0%	–1.2%	
Neuroscience and behavioural science	14	1.08%	3.6%	–2.5%	
Pharmacology and toxicology	41	3.16%	2.6%	0.6%	
Physics	14	1.08%	8.7%	–7.6%	
Plant and animal science	197	15.19%	5.0%	10.2%	0.82
Psychiatry/psychology	23	1.77%	2.6%	–0.8%	
Social sciences, general	138	10.64%	5.7%	4.9%	1.66
Space science	3	0.23%	1.1%	–0.8%	

stronger education and research systems both to enable it to fulfil its development potential and to create the kind of innovation demanded by its expanding middle class. Similarly, in Australia, serious questions remain about global competitive advantages beyond natural resources”.

Perhaps most critically, collaboration in science, technology and engineering is needed to support these ambitions.

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MR ADAM FINCH is CSIRO's bibliometric analyst working within the Science Excellence team and deploying publication analysis to demonstrate the academic impact of the organisation's research. He has worked in publication analysis for over a decade, initially as the bibliometrician for the global publisher Wiley–Blackwell before moving to Australia and working in the Research Office of Flinders University, then as a Solutions Consultant for the data provider Thomson Reuters. He is the author of several journal articles, book chapters and commissioned reports in bibliometrics, in which field he is currently undertaking PhD research at Swinburne University of Technology.

PROFESSOR JOHN WEBB OAM is Professor (Research Engagement, India) at Swinburne University of Technology. A chemist and educator with previous appointments at Murdoch University, Perth, UNESCO, several Asian universities and The University of Melbourne, he received the Medal of the Order of Australia in 1996 for establishing research networks in Asia. He served in New Delhi as Australia's Education and Science Counsellor to India, 2005–08 and as Convenor of the Task Force Report on Science Technology Innovation: Australia and India, launched in Melbourne in 2013. The Report was prepared by ATSE for the Australia India Institute at The University of Melbourne.

PROFESSOR TOM SPURLING AM FTSE is Professor of Innovation Studies in the Centre for Transformative Innovation at Swinburne University of Technology and a member of the CSIRO Board. He is a physical chemist by training who in recent years has written extensively about innovation policy and the history of Australian science and innovation. His recent work includes a book on the development of Australia's polymer banknotes, *The Plastic Banknote* (with Professor David Solomon AM FRS FAA FTSE), and a paper 'The Science and Industry Endowment Fund – supporting the development of Australian science' (with Susan Smith).

STELR program wins success overseas

One of the Academy's most visible international successes is the extension of the STELR program into other nations, with this exciting education initiative now reaching to Asia and the Pacific region – and even to Africa.

STELR's international engagement has been driven by two key factors: requests from international organisations that appreciate the quality of the STELR program and the desire of Orica, founding and major sponsor of STELR, to benefit schools in the communities where Orica has operations.

STELR's international engagement began in 2012 when it was invited to participate in the Inquiry-Based Science Education (IBSE) Roundtable in Penang. The

roundtable was hosted by the International Science, Technology and Innovation Centre for South-South Cooperation under the Auspices of UNESCO (ISTIC).

A priority agenda of ISTIC is the promotion of IBSE in developing countries. Following the roundtable, the STELR program was presented at an Innovative Teaching and Learning seminar/workshop in Penang.

These events were a great opportunity for our STELR team to network and learn about the state of STEM education in emerging economies in Africa, the Indian Ocean region, the Middle East, Asia and the Pacific.

In many emerging countries:

- a low proportion of students

complete primary school;

- schools are poorly resourced – most secondary schools have only basic science equipment;
- class sizes are much larger than in developed countries;
- teachers generally lack confidence in teaching science;
- teachers are poorly trained in running practical activities;
- teaching methods are outdated;
- pre-service teacher training, primary and secondary, is restricted in the sciences – the institutions are also poorly resourced; and
- in-service teacher training is difficult to implement for most teachers due to the lack of resources and poor communication infrastructures – for example, Indonesia has more than one million science teachers spread over 17,000 islands.

The STELR demonstrations and workshops generated interest in the STELR equipment sets and curriculum materials and the climate change and renewable energy topics resonated with the attendees.

The main drawback with implementing the STELR program in south-east Asia was the cost of the equipment packs, so new modules that did not require the specialist equipment sets (Global Warming and Oceans is one) were developed.

Support means impact

STELR's international reach has also been augmented through donations and Orica is committed to effective and targeted engagement with the communities that host its operations.

WHAT IS STELR?

STELR is the acronym for Science and Technology Education Leveraging Relevance. It is a national, secondary school, in-curriculum science program currently running in more than 450 secondary schools and with 50,000 students participating each year.

The curriculum materials have been developed with non-specialist teachers in mind. STELR incorporates contemporary teaching and learning practices, in particular an inquiry-based learning approach that engages and challenges students and teachers. Teachers are fully supported through an initial professional development program and with follow-up assistance.

Teacher evaluation of the program shows that the program has an overall positive effect on students' participation and engagement in learning science and on their perception of the relevance of science to their lives.

ENGAGEMENT WITH EUROPE A STRONG ATSE FOCUS

Collaboration has been the focus of ATSE's recent engagement initiatives with Europe. Through partnerships with the European Commission, ATSE is helping researchers and businesses in Australia and Europe better engage and collaborate on innovation and productivity.

The European Union's Framework Program 7 (FP7) ran from 2007 to 2013 and constituted the primary funding stream for research and innovation activities in Europe.

Under FP7, ATSE has been a

partner in the Connecting Australian European Science and Innovation Excellence (CAESIE) initiative, co-funded by the Australian Government Department of Industry and Science.

The role of the CAESIE program is to promote linkages between researchers and small and medium enterprises (SMEs), with ATSE managing a system of priming grants to fund initial meetings, travel and discussions between participants. Applicants must identify their potential

partners, and feature an Australia–EU and a researcher–SME connection (that is, researcher–researcher or SME–SME pairings are not supported).

A distinguishing feature of the program is the close involvement of the CAESIE program manager, Dr Mark Bradley, in the application process. Applicants receive an initial assessment and advice on their application to ensure maximum benefit is derived from the process.

Since its establishment in 2013,

Peter Pentland works with local teachers at a workshop in Bandung, Indonesia.

Education is one of three key themes of Orica's overarching community investment strategy, accounting for 24 per cent of its 2014 expenditure.

ATSE and Orica donated a class set of STELR Renewable Energy equipment kits to the SEAMEO Regional Centre for Quality Improvement of Teachers and Education Personnel (QITEP) in Science, Indonesia, which has translated the STELR curriculum materials into Indonesian and posted them on its website.

Building on the relationship with ISTIC, STELR was invited to run one-day workshops in inquiry-based science education in Indonesia in 2013 and 2014 in collaboration with the French La Main à la Pâte organisation. The participants were science teacher trainers, curriculum developers, science supervisors and national trainers and/or decision-makers from Asia-Pacific countries.

Positive feedback from these workshops resulted in STELR being invited to run a five-day workshop in Bogor Indonesia in October 2015.

As a result of the workshops, donations and direct sales to schools, STELR is now being used in schools or teacher training institutions in Timor Leste, Singapore, the Philippines, Indonesia, Fiji, Tonga, Afghanistan, Nepal and Sudan.

New STELR modules being developed will have embedded case studies and career profiles provided by the Indonesian QITEP for Science. Some of these modules will be translated into Indonesian for use in Indonesian schools.

— PETER PENTLAND, EXECUTIVE MANAGER
EDUCATION PROGRAM



INDONESIA IMPRESSED

The Southeast Asian Ministers of Education Organization (SEAMEO) is an international organisation established in 1965 among governments of south-east Asian countries to promote regional cooperation in education, science and culture in south-east Asia.

The SEAMEO Regional Centre for Quality Improvement of Teachers and Education Personnel (QITEP) in Science is hosted by the Indonesian Education Department and runs training workshops for teachers and teacher trainers in SEAMEO countries.

The Centre Director, Dr Ismunandar has endorsed the STELR concept and equipment.

"We have trialled the STELR kit with several science teacher-trainers from the Education Department. They were all very excited to try the STELR kit and general advice from them is that the kit can also be directly used with school students," he said. "They appreciated the quality of the student and teacher books, characterised by an inquiry approach. This is very rare in similar kits that have been used before."

"In terms of the equipment, the quality, convenience and safety of STELR are much better than similar renewable energy kits," he said.

PHOTO: ISTOCK



Linking with Europe – European Central Bank, Frankfurt.

CAESIE has received 118 applications via calls in 2013 and 2014, across three core priority areas: clean energy, healthy ageing through enabling technologies, and sustainable cities. Of those, 62 were successful in receiving priming grant funding after a peer assessment, with roughly even splits between researcher and SME initiated applications. European participants have come from 14 EU member states, including both foundation and new accession EU members. In total,

the priming grants program has provided more than \$500,000 of funding support.

Although the first phase of the CAESIE program is currently being evaluated, initial results point to a highly successful initiative. An overwhelming majority of CAESIE participants report that the projects funded by the priming grants have been successful, and that their collaboration would not have happened without the support provided by CAESIE.

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The priming grants provided considerable leverage and opportunity for recipients and their partners to apply for further grant funds, with current estimates indicating that more than A\$1 million was raised in Australia and €4.7 million in the EU as a result of CAESIE's initial support.

On the basis of this initial success, ATSE, the Department of Industry and Science and our European partners are currently in the process of applying for EU support for a second phase of CAESIE.

ATSE's other significant engagement program with Europe is the International Cooperation on Raw Materials (INTRAW) initiative.

Funded by Horizon 2020, this project seeks to improve European performance in raw materials extraction, processing and recycling through international cooperation, and will ultimately lead to the establishment of an International Observatory on Raw Materials to act as a clearinghouse for information on mineral production.

HORIZON 2020

Horizon 2020 is the biggest EU Research and Innovation program ever, with nearly €80 billion of funding available over the seven-year period 2014–20, in addition to the private investment that this money will attract. Horizon 2020 has the political backing of Europe's leaders and the Members of the European Parliament. They agreed that research is an investment in the future and so put it at the heart of the EU's blueprint for smart, sustainable and inclusive growth and jobs.

Led by the European Federation of Geologists, the project includes partners in eight EU countries and focuses on five target countries with successful raw materials industries – Australia, the US, South Africa, Canada and Japan.

ATSE is the Australian partner for the project and has a primary role in helping to collate and analyse available data on the Australian minerals industry,

focusing on policy and economic settings, research and education systems, and industry and trade arrangements.

The project was launched in February 2015 and work has begun on preparing target country context analyses and specific reports on education, research and industry.

ATSE has formed an Expert Reference Group of Fellows with backgrounds and expertise in the minerals sector to advise on the project, chaired by Ms Denise Goldsworthy FTSE. The entire project runs for three years, concluding with the launch of the Observatory in 2018.

Both CAESIE and INTRAW illustrate the vital importance of collaboration to science and technology-based improvements in productivity collaboration among industry, government, SMEs and academia, and between Australia and other countries.

ATSE has consistently highlighted this message to the Australian community, and through projects such as these, will continue to do so with our overseas partners.

– DR MATT WENHAM, EXECUTIVE MANAGER
POLICY AND PROJECTS

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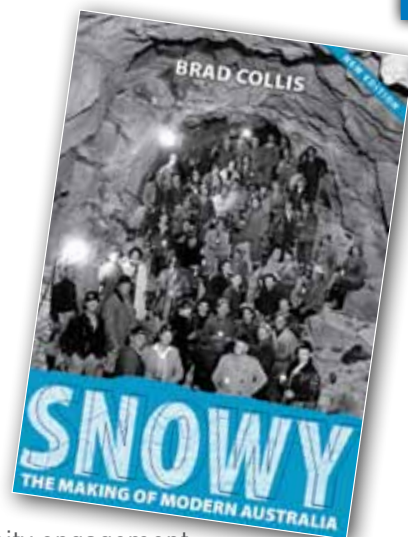
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ATSE IN ACTION

Clunies Ross Medals awarded at glittering Brisbane dinner

A crowd of more than 500 attended the 2015 Clunies Ross Awards dinner at the Brisbane City Hall on 28 May to recognise some of the nation's best achievements in commercialisation of innovation.

Organised by a committee of the ATSE Queensland Division, the dinner continued a long tradition of landmark Clunies Ross events.

The dinner attracted some stellar guests including former Premiers Mr Peter Beattie AC and Mr Mike Ahern AO FTSE. The Vice-Chancellor of the University of Queensland, Professor Peter Høj FTSE, delivered the opening address, Academy President Dr Alan Finkel AO FTSE delivered the closing address and the guest speaker was ARC Laureate Fellow and Nobel Laureate Professor Brian Schmidt AC FRS FAA.

Two ATSE Fellows were honoured.

Dr Cathy Foley PSM FTSE and Mr Keith Leslie – both from CSIRO – shared a Clunies Ross Award for their work on LANDTEM™, a highly sensitive magnetic detection device

capable of detecting ore bodies with extremely weak magnetic fields.

Associate Professor Leigh Ward, from UQ, was honoured for his work using bioimpedance spectroscopy (BIS) to develop an accurate yet inexpensive tool for early detection of lymphoedema, the accumulation of excessive amounts of protein-rich fluid resulting in swelling of one or more regions of the body, due to a mechanical failure of the lymphatic system.

Professor Zhiguo Yuan, also from UQ, was awarded for his campaign to “put science in sewers”, which has fundamentally changed industry's understanding and practice around sewer corrosion and odour management.

Associate Professor Jim Patrick AO FTSE received a Lifetime Achievement Award. He is one of the original engineers who pioneered the development of the multichannel cochlear implant and is recognised as a world authority on cochlear implants.

The following day, award winners and leading scientists joined 200 students and teachers from Queensland schools for the



The Clunies Ross Medal.

Wonder of Extreme Science event, which showcased both ATSE's STELR program and the Queensland Wonder of Science Program at Queensland University of Technology.

Full coverage of the event: August issue of Focus.

New format for 2016 Clunies Ross Awards

Nominations for the 2016 Clunies Ross Awards will open on Monday 3 August and close on Friday 30 October.

There will be a new format and categories for the Awards in 2016.

Over the past 25 years the Clunies Ross Awards have recognised contributions by dedicated individuals to the application of technology for the benefit of Australia.

In recognition of the complex nature of such activities, from 2016 the Awards will be made in three categories with a single winner in each category and announced at ATSE's Annual Challenge Conference in Sydney, planned for 15 and 16 June.

The three award categories are: Clunies Ross Entrepreneur of the Year Award

For those who have been responsible for the creation of a product or service with a

financially successful outcome, in either an early stage or mature company environment with demonstrated impact for Australia.

Clunies Ross Knowledge Commercialisation Award

For those who have been responsible for a technology that has been commercialised, most likely by licensing, with a financially successful outcome.

Clunies Ross Innovation Award

For those who have been responsible for the adoption of a technology, at a stage where the financial outcomes are yet to be realised and/or the benefits are of a measurable broad community nature.

These changes follow a review of the Awards last year by former Director Mr John Grace FTSE, who will chair the Selection Committee for the 2016 Awards.

The award criteria are:

- 1** The award winner has made an identifiably significant contribution to the advancement of industry and/or the community through the application of science and technology for the economic, social and environmental benefit of Australia;
- 2** The award winner is able to demonstrate that the impact or potential impact of the technological based innovation; and
- 3** The award winner has advanced the promotion of innovators and community awareness of technological innovation.

A Clunies Ross Award is a personal, rather than corporate, award. If the nominee believes the award should be shared by a number of people (usually no more than three), she/he must justify this, including demonstrating why the contribution could not have been achieved without each of the nominees being associated for the majority of the total time involved.

ATSE IN ACTION

We should value our research better

The Academy has spearheaded a campaign to change the way Australia values research.

There is growing acknowledgement in government and industry that the Excellence in Research for Australia (ERA) model – currently the only accepted measure of research ‘quality’ – cannot adequately encourage research commercialisation or other translation into community benefit.

This is against a background where Australian universities, publicly funded research institutes and industry are far less engaged in research collaboration than their counterparts in other countries, which is concerning, given that such collaborations are the engine room behind the advanced manufacturing industries of the future.

The key principle is to use the amount of revenue from industry and other research end-users as a measure of research engagement.

To drive policy thinking towards a better-balanced approach, ATSE has produced a major report, *Research Engagement for Australia (REA)*, which proposes to reward research engagement, under the REA banner, alongside research excellence (ERA).

The key principle is to use the amount of revenue from industry and other research end-users as a measure of research engagement.

ATSE argues that this would impose negligible costs because it would use data already submitted by universities in annual returns and as part of the ERA process.

ATSE believes that use of the REA metrics will help increase the return on public investment in research in science, technology, engineering and maths (STEM) and humanities and social sciences (HASS) alike. Importantly, the metrics are calculated for disciplines within universities (by Field of Research code), so that comparisons are made between universities, not between disciplines.

ATSE President Dr Alan Finkel AO FTSE says it is vital to reward activities by researchers directed at innovation.

“The ERA recognises and rewards

scholastic achievement but in some cases, without intention, it deters engagement by researchers with industry, or with key communities such as hospitals,” he says.

“REA will foster collaboration and knowledge exchange – and encourage research translation and impact.

“Researchers are too often forced to choose between research and commercial careers, rather than being able to nurture their discoveries and innovations to market successfully.”

Dr Finkel acknowledges the value of the ERA, which he describes as a robust quality measure of research excellence.

“We don’t question that at all, but because it’s the only measure out there, researchers and

their managers at universities are focused on doing well in that measure.

“It’s intended to encourage researchers to elevate themselves in research excellence but, inadvertently, it can dissuade researchers from engaging with industry and nurturing the fruits of their research into the market because they are under pressure to publish and be cited.

“We think it’s important that the Australian community and the Australian Government receive a measurable return on investment in research beyond just the research itself. It must be translated into community and commercial benefit.”

ATSE Vice-President Professor Peter Gray FTSE, who chaired the Steering Committee which produced the *Research Engagement for Australia (REA)* report, commented: “I would like to acknowledge the hard work and enthusiasm of the members of the Steering Committee who represented at a high level the humanities and social sciences and STEM disciplines.

“Initial trials show that the resulting REA metric is a simple, robust measure of research engagement, based on data already collected by the university sector, which can be applied within the various research disciplines.



“It would be a relatively simple exercise to determine the REA metric, and the exercise of determining such a metric would modify behaviour within the university sector and encourage research collaboration and uptake by industry and other end users.”

The ATSE report was welcomed by the Minister for Education and Training, the Hon Christopher Pyne, who said it provided a practical framework for measuring how universities and researchers work with industry and other stakeholders.

“The findings of this report highlight the importance of collaboration between researchers and industry,” Mr Pyne said.

“The metrics developed in the *Research Engagement for Australia* report have the potential to increase the return on public investment in science, technology, engineering and maths research as well as research in humanities and social sciences.

“ATSE’s work provides encouragement to researchers to engage with industry. What it does not explicitly do is encourage industry to engage with universities. I urge business leaders to meet researchers at least halfway – to engage with them more often, and more deeply, and to bridge the gap which currently exists between the two sectors.

“The Government is committed to ensuring that Australia has a well-functioning research sector as it is vital to our productivity and our future.”

The report, funded by the Department of Education and Training, is on the ATSE website: [Publications > Reports > Industry&Innovation](#)

ATSE IN ACTION

PHOTO: iSTOCK.COM

Time to use stormwater, says ATSE submission

Australian towns and cities are drastically underutilising stormwater, missing out on the chance to reduce pollution and erosion of urban waterways.

Stormwater is a valuable potential resource that could provide a significant alternative water source for a range of productive applications, but its full potential is still to be realised.

Existing technologies are capable of providing stormwater capture but water governance rules need updating to take advantage of stormwater potential.

These were key aspects of ATSE's May submission to the Senate Environment and Communications References Committee inquiry into Australia's stormwater resource.

The Academy said better management of urban stormwater was essential as the current poor management of stormwater led to societal, economic and environment costs through flooding and degradation of waterway and bays.

ATSE Water Forum Deputy Chair Professor Ana Deletic FTSE led the development of the submission and re-emphasised ATSE's position on stormwater when she appeared at a Committee hearing in Melbourne along with ATSE's Executive Manager of Policy and Projects, Dr Matt Wenham.

ATSE made five recommendations on how to better use Australia's stormwater in Australia, including:

- further development of stormwater harvesting technologies;
- wider implementation of these systems to relieve pressure on ageing drainage infrastructure;
- development of economic models to better understand the total community costs and benefits of complex stormwater systems;
- more sophisticated governance frameworks for managing multi-functional and decentralised stormwater assets, in an area that is traditionally highly centralised; and
- better linkages between stormwater management and urban planning processes.

ATSE noted that uncontrolled stormwater damaged urban infrastructure during large

storm events and ongoing investment would be needed to ensure that drainage systems met service needs, amplified by ageing drainage infrastructure, rapid increases in urban population and the densification of cities.

It also noted the extensive impervious (paved) areas in cities pushed excessive stormwater flows into waterways, causing erosion and pollution. Stormwater can also carry large amounts of heavy metals and nutrients, which can increase the risk of algal blooms.

ATSE emphasised that the full potential of urban stormwater was still to be realised, given its volume and location.

It noted that the volume of stormwater discharged from houses annually in Melbourne was similar to the entire household water demand of the city and in Brisbane it exceeds demand by about 50 per cent.

Stormwater generally requires less treatment than other wastewater sources, such as sewage or industrial waste, and it can be harvested through passive treatment and distribution methods, based on natural processes, with much less energy than many other water treatment and supply solutions.

Stormwater harvesting could protect and enhance the health of urban streams by restoring flows and water quality to approximately pre-development levels and is



Brisbane in flood in 2001.

the only water source whose use will benefit the environment, rather than degrade it.

It also noted Australian communities were more prepared to accept stormwater than wastewater and that more than 100 stormwater harvesting systems were built during the Millennium Drought in Victoria, largely without participation from the water industry.

The submission is on the ATSE website: [Publications > Submissions > Natural Resources](#)

STELR NOW IN 450 SCHOOLS

ATSE signed up its 450th school to the STELR program in May and now has 453 STELR schools – 447 in Australia and six in New Zealand.

The 450th school signed up was Sydney's Knox Grammar School, whose STELR Renewable Energy Module was purchased through the support of an ATSE Fellow.

The STELR program began in 2008 and was trialled by a small number of schools in 2009.

The first 187 schools received the STELR Renewable Energy Kits through a Federal Government grant. Since then, STELR materials have been sold to schools, some of which have received full or partial sponsorship from a variety of supporters.

The program is an indicator of the generosity of the STELR sponsors and private donors, in particular Orica Pty Ltd and the Australian Power Institute.

STELR has made substantial impact across Australia with Victoria hosting 117 STELR schools, followed by NSW (109), Queensland (93), SA (40), WA (31), Tasmania (25), the Northern Territory (22) and the ACT (10).

ATSE IN ACTION

Three issues key to smart grids discussion

The future community embrace of intelligent electricity distribution grids depends on three diverse but key issues, ATSE President Dr Alan Finkel AO FTSE, told the Intelligent Grids symposium in Sydney in May.

Smart grids needed to be able to be scaled up to reach their potential.

"Most of my non-engineering friends have great ideas for what they can do to reduce their personal resource footprint, but in most cases these ideas do not scale up," he said.

"As engineers and scientists it is our job

to think big, about solutions that will have substantial impact."

The second point rested on human behaviour and the way we would relate to time-of-day pricing and centrally mandated load management, for instance.

"To accept external overrides I would either have to be behaviourally modified or financially incentivised – thus the shift to such approaches, while entirely consistent with conferring more responsibilities to our intelligent grid, will need to be carefully managed."

The third issue was government. In an

era of short-term planning by government, industry should look deepest into things it could achieve without relying on government while addressing government-dependent solutions more slowly.

Dr Finkel addressed an audience of some 80 delegates at the one-day symposium, organised by the NSW Division of ATSE at the NSW Department of Trade and Investment Centre in Sydney.

We will carry an extended report on the symposium in the next edition of Focus.

ATSE RECOMMENDS OECD EMISSIONS REDUCTION TARGET

ATSE has recommended that Australia commits to meeting at least the median 2050 emissions reduction target of other OECD countries, pending a more detailed analysis of what measures can realistically be adopted to achieve this figure.

This was the key element of the Academy's recent submission to the Department of Prime Minister and Cabinet's UNFCCC Taskforce on the consultation to determine Australia's post-2020 emissions reduction target.

The Australian Government will commit Australia to this target at the upcoming 21st

Conference of the Parties (COP 21) meeting in Paris in November.

ATSE said, as a large per-capita emitter, Australia would need to consider how any post-2020 target would be achieved, while minimising any impacts on the economy or Australia's competitiveness.

The existing heavy reliance on coal for power generation, the lack of gas on the east coast that could be utilised for high-efficiency centralised generation, and the lack of the option of nuclear energy would make this task a challenging one. Ensuring that any regulatory burden is minimised would also be important.

The ATSE submission highlighted the essential role of technology in providing low carbon energy sources, with a focus on the need to incentivise investment in the development and deployment of energy technologies.

The submission outlined a proposed scheme that could be introduced to provide tax incentives for investment, as a supplement or replacement for the Government's Direct Action policy.

The ATSE submission is online at [Publications > Submissions > Energy](#)

ACOLA REVIEWS RESEARCH TRAINING SYSTEM

The Australian Council of Learned Academies (ACOLA) will review Australia's research training system to ensure that it meets Australia's research needs in the 21st century.

ACOLA will engage with higher education and research institutions, peak bodies, industry and government agencies to identify opportunities to improve research training in Australia.

The four learned academies that comprise ACOLA are ATSE, the Australian Academy of Science, the Academy of Social Sciences in Australia and the Academy of the Humanities.

The review's final report will be provided in March 2016 to Education Minister Christopher Pyne, who commissioned the project.

"A highly skilled research workforce is vital to Australia's future prosperity," Mr Pyne said. "Other countries are already exploring new research training models, with more structured

PhD programs, greater industry engagement, and alternative entry pathways into a PhD.

"Australia's research training system will fall behind if our research training models are not comparable with the best in the world. This review will help ensure our system is truly world-class and capable of underpinning our capacity for learned inquiry, innovation and productivity."

The review will examine Australia's research training system and consider the priorities for reform, including how to:

- ensure that Australia's research training models are comparable with the best in the world;
- ensure that research graduates are equipped for and achieve employment outcomes in a range of sectors, including academic teaching, research and industry;

- provide greater opportunity for industry relevant research training, including through support for industry relevant research projects and experience; access to industry and business relevant skills within research training programs, such as entrepreneurial skills; and recognition of prior experience in industry or other relevant employment;

- remove barriers in the regulatory framework to facilitate innovation in degree models and align with international best practice, including facilitating opportunities for more structured research training programs (including through professional development, coursework and internships); and supporting alternative pathways to a PhD that align with international best practice, such as master's degree preparatory models;

ATSE IN ACTION

Infrastructure Australia: prioritising long-term investment



The process must be transparent. It should encourage robust discussion, debate and engagement in order to achieve community acceptance. Cost-benefit analyses need to be open to public scrutiny.

– PETER WATSON FTSE

Infrastructure – including transport, telecommunications, energy and water – plays a critical role in our personal and business lives, and is the key to Australia's long-term prosperity.

Major infrastructure is expensive, running into billions of dollars, and has a design life of many decades.

The long-term nature and high cost of major infrastructure projects means that making the right decision is crucial. Imprudent populist decisions fuelled by the short election cycle detract from our future growth and social amenity.

These were key points made by Mr Peter Watson FTSE when he addressed the first of the ATSE's NSW Division 2015 Luncheon in the City Series, themed 'Infrastructure – the Key to Australia's Growth'.

The 2014 Productivity Commission's report on Public Infrastructure highlighted an "urgent need" to comprehensively overhaul processes for assessing, planning and developing infrastructure projects.

Against this background Mr Watson addressed 66 fellows and guests at the Union Club in Sydney in March on *Australia's priority infrastructure for the future: The new role of Infrastructure Australia*.

A former CEO of Transfield Services Pty Ltd, Director of Infrastructure Australia and Chair of Victoria's Regional Rail Link Authority and Major Transport Infrastructure Program, Mr Watson was well-qualified to tackle this subject.

He described the processes that enabled the Victorian Rail Link project to deliver a \$4 billion project ahead of time and under budget with a world-class safety record and no industrial disputes. He highlighted the central role of a project delivery authority, the importance of collaboration between industry and the public sector, stakeholder and contractor management, a culture of continuous improvement, governance, community engagement and transparency.

The project, which involved 14 million man-hours and 15,000 individuals, delivered the infrastructure that provides capacity for 23 metro and 10 regional new services with several new communities gaining access to rail for the first

time. It was awarded Infrastructure Australia's 2014 Project of the Year.

Mr Watson's key messages were:

- major infrastructure projects must have bipartisan support and commitment;
- the planning and prioritisation process needs to be rigorous and transparent; and
- major infrastructure projects must be in the national interest, but developed in consultation with States and Territories and local government.

He noted that Infrastructure Australia was currently undertaking a National Infrastructure Audit and 15 Year Plan to assess and prioritise infrastructure needs throughout the country.

The audit, which is due for release shortly, primarily has an economic and productivity focus and also considers social and environmental issues.

Project proposals must be transparent, have full cost-benefit analyses and encourage robust debate and community engagement in order to gain acceptance, he said.

He hoped that, through a transparent process independent of external pressures, the deep experience of Australia's government and private sectors could be combined into a policy and community consensus for improved, optimal infrastructure for Australia.

Mr Watson's talk inspired almost an hour of discussion ranging across the relative roles of State and Commonwealth governments and the private sector; capability development and up-skilling the workforce; the long-term planning imperative; integration between specific projects; the need for high-quality, innovative engineering; the need for large-scale projects that excite 'national passion'; the role of government long-term debt funding and the advantage of being able to achieve independence from the political cycles.

The general consensus was that the process of independent planning and assessment championed by Infrastructure Australia would serve Australian well into the future.

- support admission and attainment for PhD candidates from non-traditional backgrounds, including supporting Indigenous research students;
- ensure the research workforce pipeline is secure in fields of national importance, including areas aligned with national science and research priorities;
- ensure that our research training system delivers a high quality research and learning environment and continues to support student choice and competition between providers; and
- make the best use of current resources invested in research training by all stakeholders, including universities, industry and the Australian Government.

WOMEN IN TSE

CSIRO scientist wins Feynman Prize

CSIRO virtual nanoscientist Amanda Barnard has been awarded the California-based Foresight Institute's prestigious 2014 Feynman Prize for Nanotechnology (Theory).

Dr Barnard, who heads the CSIRO Virtual Nanoscience Laboratory, is a theoretical physicist and a pioneer in the thermodynamic cartography of nanomaterials.

She is the first Australian in the prize's 22-year history to win the award and also the first female winner.

The award is named after Richard Feynman a renowned physicist and Nobel Prize winner from last century who is acknowledged as the 'father' of quantum electrodynamics.

Dr Barnard's award-winning work required the use of powerful supercomputers to make the most of decades of big data on tiny nanoscience, gaining insights that might one day lead to extraordinary, life-changing products – self-cleaning surfaces, fuel cells for harnessing energy, printable inks that conduct electricity and new drugs to cure life-threatening illnesses.

Just a few years ago, she made a fundamental discovery on diamond nanoparticles, finding that they have unique electrostatic



Amanda Barnard

properties that make them spontaneously arrange into very useful structures, with huge implications for improving healthcare.

Already, her diamond discovery has underpinned the development of a potentially life-saving chemotherapy treatment that targets brain tumours, created by the University of California, Los Angeles.

Among her other research highlights, Dr Barnard has developed a new technique for investigating the shape of nanomaterials including their size, temperature or potential uses in chemistry.

NPC ADDRESS ON GENDER EQUITY

The Committee for Economic Development of Australia (CEDA) is taking gender equity to the National Press Club (NPC) in Canberra on 3 July for a discussion on the importance of increasing diversity to enhance business productivity and overcome imbalances in the country's quest for workplace equality.

The NPC event will examine:

- policy levers to ensure fair and equitable access to family caring responsibilities for women and men;
- the impact on gender equity in a shifting public service – internal and downstream;
- commitments to diversity, rigour and merit by government, corporate and the not-for-profit sectors;
- delivering a consistent message to achieve greater equality at senior levels; and
- actions for future leaders in the public, private and third sectors.

Speakers will be: Ms Kate Carnell AO, CEO of the Australian Chamber of Commerce and Industry and former ACT Chief Minister; Ms Lisa Paul AO PSM, Secretary of the Commonwealth Department of Education and Training; and Mr Troy Roderick, Head of Diversity and Inclusion, Telstra.

\$17 million to help lift teacher quality

The Australian Government will provide an additional \$16.9 million over four years to the Australian Institute for Teaching and School Leadership (AITSL) to improve initial teacher education and to ensure teacher graduates are 'classroom ready'.

Education and Training Minister Christopher Pyne said the funding would equip AITSL to implement the recommendations of the Teacher Education Ministerial Advisory Group (TEMAG) report, starting with implementing a literacy and numeracy test for initial teacher education students from 2015.

Through the funding, AITSL will be able to respond to the TEMAG report by:

- having universities provide transparent statements of student selection systems including detailing their bonuses and real ATAR cut-offs;
- overhauling the in-class practical element of teaching degrees with a focus on how to teach reading, writing and phonics;
- providing robust assessment of graduates to ensure they are classroom-ready;

- introducing a specialisation for primary school teachers with a focus on science, technology, engineering and mathematics (STEM) and languages; and
- providing better national workforce planning and research regarding teacher skills versus the changing needs of schools and students.

Mr Pyne said the extra funding would enable AITSL to seek better quality information from teacher training institutions so that a more accurate assessment of course quality, and therefore graduate readiness to teach, could be made.

STEM BOOST FOR 62 TEACHERS

More than 60 teachers have completed the teacher enrichment and professional development program at the new STEM Teacher Enrichment Academy at the University of Sydney, which supports and mentors practising teachers in science, technology, engineering and mathematics (STEM) disciplines to inspire students to learn STEM subjects and choose careers with STEM pathways.

Three faculties – Education and Social Work, Science, and Engineering and Information Technologies – have combined to provide this training,

WOMEN IN FOCUS

'Choose Maths' targets women

The Australian Mathematical Sciences Institute (AMSI) and the BHP Billiton Foundation have launched 'Choose Maths', a five-year national program that aims to turn around public perception of mathematics and statistics as a career choice for girls and young women.

Choose Maths begins with a focus on maths education in primary and secondary schools. The BHP Billiton Foundation has contributed \$22 million toward the partnership, which will enable AMSI Schools to expand its outreach capacity across Australia over the next five years.

The program aims to contribute to the health of the mathematics pipeline in Australia from school through university and out to industry and the workplace by:

- providing mathematics-ready teacher professional development in 120 schools across Australia and resources for every school in the country;
- developing a national mathematical sciences careers awareness campaign;
- establishing an 'inspiring women in mathematics' network; and
- holding annual BHP Billiton awards for excellence in the teaching and learning of mathematics.

Research-based strategies for encouraging girls and young women into mathematics and STEM-related courses will be core to the program. The large-scale careers awareness campaign will be driven by research into community perceptions about mathematics.

"The low participation of girls and women in the study of the mathematical sciences and in the quantitative professions is a significant national social and economic challenge," says AMSI Director, Professor Geoff Prince.

"This landmark five-year project aims to build self-sustaining education communities where girls and young women share equally in the rewarding careers and rich life experiences that mathematics offers."

AMSI emphasises that STEM skills are critical for Australia's productivity and global competitiveness, with innovation-active businesses twice as likely to use engineering and science skills, and three times more likely to use information and communications technology skills than innovation-inactive businesses.

AUSTRALIA'S DECLINE IN MATHEMATICS

- In 2010 the Australian Industry Group said more than 75 per cent of employers responding to a survey reported that low levels of literacy and numeracy affected their businesses.
- 40 per cent of Year 7 to 10 maths classes nationally are taught by teachers who are teaching 'out of field'. These teachers are qualified teachers, but their undergraduate course was not in mathematics or did not contain sufficient mathematics for them to undertake a method subject in their diploma of education. This figure is roughly three times the international average and twice the estimated rate for Year 7 to 10 science classes.
- Fifty-four per cent of adult Australians have only basic numeracy skills.

It argues that, if no action is taken, demand for tertiary graduates with STEM skills, particularly mathematics, will continue to outstrip supply.

It also notes that the percentage of male mathematical sciences graduates in Australia sits at half the OECD average, and for women this drops to one-third and backs Government estimates that between now and 2020 Australia will need new PhD graduates to grow the expert mathematical and statistical workforce by 17 per cent – a currently unattainable figure.

supported by science teachers from around Australia.

The 62 participants from 13 NSW schools have completed their second residential in-service at the university and have been supported in their classrooms by teacher mentors and new resources.

"Inspiring teachers are among the secrets to arresting the decline in students enrolling in STEM subjects, including a fall in the number of secondary students enrolling in intermediate and advanced maths since 1995," said Science Minister Ian Macfarlane.

"And despite a 3.5 per cent growth in demand from industry for mathematics and statistics graduates, enrolments in university maths majors fell by 15 per cent between 2001 and 2007. Australia must ensure STEM studies are providing graduates with both a strong academic foundation and practical industry-relevant skills."

HALF OUR UNIVERSITIES MAKE THE TOP 400

More than half of Australia's 39 universities were listed in the top 400 of the *Times Higher Education World University Rankings 2014-15*.

Melbourne (33), ANU (45), Sydney (60), Queensland (65) and Monash (83) all ranked in the top 100, followed by NSW (109), Western

Australia (157) and Adelaide (164). The University of Technology, Sydney, Newcastle, Queensland University of Technology, the University of South Australia and Wollongong University all ranked between 200 and 300. Charles Darwin, Deakin and Macquarie universities were ranked 301 to 350, followed by Curtin, Murdoch, Swinburne and Western Sydney (351 to 400).

In Engineering and Technology, Melbourne and UQ (37), Monash (48), UNSW (63), UniSA (69) and UTS (95) were highest ranked. In Physical Sciences, the top 100 included ANU (28), Melbourne (30) and UQ (87).

Seven Australian universities were ranked in the top 50 newer universities – those less than 50 years old. These were UTS (21), Newcastle (30), Wollongong (31), QUT (33), UniSA (35), Deakin (45) and CDU (48). Another 16 were ranked in the top 100 – UWS (56), Murdoch (65) and Swinburne (65), La Trobe (75), Flinders (77), Curtin (81), Griffith (82), Edith Cowan (90) and RMIT (97).

The *QS Rankings 2014-15* were again dominated by US (6) and UK (4) universities, with ANU (25), Melbourne (33), Sydney (37), UQ (43) and UNSW (48) in the top 50, followed by UWA (89) and Adelaide (100).

The QS top 50 less than 50 years old included Newcastle (19), UTS (21), Wollongong (26), QUT (28), RMIT (32), Griffith (38), Curtin (40), UniSA (41), James Cook (46) and Deakin (50).

An eyeball view of the Gatton solar panels.

\$166.7 million from ARENA and \$64.9 million from the NSW Government. It will see new solar plants constructed in Nyngan and Broken Hill with a combined generation capacity of up to 155MW.

SCIENCE AND RESEARCH KEY TO GAS POLICY

Some of Australia's most significant opportunities for growth – as an energy superpower – will come from its onshore gas assets, according to Industry and Science Minister Ian Macfarlane.

He pledged government support for “responsible development” of Australia's unconventional gas resources, including coal seam gas, shale gas and tight gas, when he launched the Government's Domestic Gas Strategy in April, planned to provide the framework for development based on comprehensive scientific data and expertise.

The Domestic Gas Strategy builds on the Government's Energy White Paper, which identified the onshore gas industry as an important energy source for Australia and for export.

The strategy would ensure all decisions about the development of gas reserves were based on a comprehensive body of science and research that was detailed, easily accessible and answered the questions communities were asking. Mr Macfarlane said.

“Our Energy White Paper has laid out a blueprint for growth in our energy sector, by focusing on increasing competition, getting the most out of our energy resources by enhancing our energy productivity, and maximising investment in our energy sector.

“Unconventional gas, including coal seam and shale gas, is already a big part of Australia's gas supply, accounting for around 40 per cent of production in the eastern Australian gas market. It will become even more important over the next decade in meeting domestic and international demand.

“By undertaking and distributing scientific research, the Australian Government supports the work of regulators and helps communities realise the benefits of responsible development. A vast amount of research has been completed or is underway to answer crucial environmental, health and other socio-economic questions.

“Greater understanding of the importance of gas development is essential to help underpin Australia's future national economic wellbeing. The Government is listening and responding to community concerns.

“We also expect industry to take responsibility for its own future. This means being involved in meaningful and proactive engagement with communities and acting to understand and mitigate unwanted environmental or social impacts of its activities.

“New gas development will ensure farmers' rights and bring tangible benefits for local communities while protecting our land and water resources,” he said.

Farming and gas together.



UQ opens its Gatton PV research centre

The University of Queensland has launched the largest solar photovoltaic (PV) research facility in the southern hemisphere at its Gatton research facility between Ipswich and Toowoomba, 80 kilometres west of Brisbane.

Industry and Science Minister Ian Macfarlane said the Gatton research facility was part of a \$400 million project led by AGL Energy and supported by \$166.7 million of Australian Government funding through the Australian Renewable Energy Agency (ARENA).

UQ is the lead researcher for the AGL PV project, comprising the nation's biggest solar plant at two sites in New South Wales.

“When complete, the Nyngan and Broken Hill sites will have a combined total generation capacity of 155MW and the ability to generate enough renewable energy to power more than 33,000 homes each year,” Mr Macfarlane said.

“UQ received \$40.7 million of Australian Government funding to build the 3.3MW research plant at its Gatton campus, which will test the technologies, performance, energy storage and operational strategies underpinning the AGL project.

“The plant is fully integrated into the Energex network and will supply 30 per cent of the Gatton campus's energy needs with excess generation being supplied to the Lockyer Valley.”

AUSTRALIA'S LARGEST SOLAR PLANT FIRES UP

The first section of the Nyngan Solar Plant in western NSW is online and feeding renewable energy into the National Electricity Market.

Close to 350,000 solar photovoltaic (PV) panels are producing up to 25MW of electricity. Once complete, the plant will output up to 102MW, enough to power 33,000 homes per year.

ARENA CEO Mr Ivor Frischknecht said the project was paving the way for more large-scale solar plants to be built in Australia.

“The AGL solar project will make similar plants more competitive in Australia by helping to break down financial, regulatory and technical barriers. In addition to creating jobs, boosting skills and contributing to local communities, the development of utility-scale solar is vital to a diverse energy future,” Mr Frischknecht said.

The plant is part of the AGL solar project, which is supported by

PHOTO: ADAM HARPER



Hyundai launches its hydrogen car

Hyundai Motor Company Australia has unveiled Australia's first hydrogen-powered car – the Hyundai ix35 Fuel Cell.

The Fuel Cell Electric Vehicle (FCEV), built in South Korea, arrived in Australia in June 2014 and has been undergoing operational trials since.

Hyundai says the arrival of the first test vehicle and the commissioning of Australia's only hydrogen refuelling station (HRS) are pioneering steps toward the commercial availability of emissions-free hydrogen-powered vehicles in Australia.

Hyundai has installed the HRS at its headquarters in Macquarie Park, Sydney. It currently uses hydrogen provided by gas partner Coregas Australia, but will soon create its own hydrogen onsite through the use of a solar-powered electrolyser. The HRS, supplied by American company Air Products, is fully operational.

"Hyundai strongly supports the idea of a 'Hydrogen Highway' infrastructure roll out in Australia, like those already in operation overseas," says Hyundai Motor Company Australia CEO, Mr Charlie Kim. "We look forward to engaging in industry and partner discussions about ways to further motivate the adoption of hydrogen motoring in Australia and to offering some viable options to our Federal, State and local policy-makers."

In Europe and the US, 'Hydrogen Highways' have been built by government and private partnerships for use by FCEVs like the ix35 Fuel Cell, along with other hydrogen-powered vehicles such as buses.

"One of our ideas is the 'Hume by Hydrogen', which could link Australia's two largest cities via the nation's capital. It would require refuelling stations in Melbourne, Sydney, Canberra, Goulburn and Albury and could see hydrogen vehicles, including buses, running on a busy highway emitting nothing but water vapour.

"A project like the 'Hume by Hydrogen' would demonstrate the benefits of hydrogen transport very effectively – we would like our ix35 Fuel Cell to start a meaningful conversation about this technology for the benefit of future generations," Mr Kim said.

Hydrogen from the ix35 Fuel Cell fuel tank is mixed with air and converted to electricity by a fuel cell stack. The electricity then powers the ix35 Fuel Cell's electric motor.

Hyundai says the vehicle is near-silent, efficient, emissions-free and very safe, having passed the stringent American NHTSA crash test.

The Hyundai ix35 Fuel Cell.

It is described as being as practical and useful as a standard petrol or diesel-powered ix35, with near-identical interior space and comparable range and performance.

The ix35 Fuel Cell develops 100kW of power and 300Nm of torque and has an official maximum range of 594 kilometres.

SOLAR-DIESEL POWER PLANT LAUNCHED

Australia's first operational redeployable, solar-diesel hybrid power plant has been launched in regional Queensland – supplying power to a 350-bed accommodation village in for a large construction project.

The one megawatt (1MW) hybrid solar diesel plant includes 144kWp (kilowatt-peak) of solar photovoltaics (PV) was installed by Laing O'Rourke, Australia's largest privately owned construction company

ARENA CEO Ivor Frischknecht says the plant – delivered, unpacked and fully functional in one week – is a clear demonstration of a versatile alternative to diesel-powered generators and is understood to be the world's first fully redeployable, large-scale, solar-diesel hybrid power plant.

"The Laing O'Rourke solution is a real game-changer – it provides off-grid locations with a viable energy alternative to a portion of expensive, trucked-in diesel and overcomes the barriers and risks associated with permanent, fixed framed solar installations," Mr Frischknecht says.

"The plant can be scaled up or down by adding or removing power modules and can be packed up and moved elsewhere when it is no longer needed. This allows the solar panels to be re-used several times over their lifespan and is suitable for construction projects, mine sites and other applications where temporary power is required."

ARENA partnered with Laing O'Rourke by providing \$410,000 support for the feasibility and design work and a further \$450,000 for the \$1.4 million demonstration project.

Laing O'Rourke Managing Director Cathal O'Rourke says the partnership has produced an innovative new solution that could potentially change the renewable energy landscape in regional and remote Australia.

"We believe this investment and innovation could provide huge benefits to remote communities, business operations and construction projects in the future, as well as have particular benefits for events that require rapid deployment of power units – such as disaster recovery," Mr O'Rourke says.

SOLAR AFLOAT

Kyocera Corporation and Century Tokyo Leasing have announced that Kyocera TCL Solar LLC, a joint venture established by the two companies, has completed construction of two floating mega-solar power plants at Nishihira Pond and Higashihira Pond in Kato City, Hyogo Prefecture, Japan.

The plants, inaugurated in late March, will generate an estimated 3,300 megawatt hours (MWh) per year in total – enough electricity to power approximately 920 typical households.

Kyocera is a multinational electronics and ceramics manufacturer headquartered in Kyoto and Century Tokyo Leasing is one of Japan's leading leasing and finance companies.

IEA says treble spend on low-carbon R&D

The International Energy Agency has released its flagship report, *Energy Technology Perspectives 2015*, which sees the development and deployment of new energy technologies as key to mobilising climate action and urges policymakers to step up efforts to support them.

"The stakes are high for the energy sector, but it is also no stranger to profound technological change. An incredible chain of innovations in the energy sector has been at the vanguard of social and economic transformation for over a century," said IEA Executive Director Maria van der Hoeven. "It is exciting to see the progress being made by solar panels and fuel economy improvements for passenger cars today, to name but two," she said.

"But we cannot be complacent. We are setting ourselves environmental and energy access targets that rely on better technologies. Today's annual government spending on energy research and development is estimated to be US\$17 billion. Tripling this level, as we recommend, requires governments and the private sector to work closely together and shift their focus to low-carbon technologies."

Energy Technology Perspectives 2015 provides a comprehensive analysis of long-term trends in the energy sector, centred on the technologies and the level of deployment needed for a more environmentally sustainable, secure and affordable energy system. Recent success stories, such as the rapid growth of solar photovoltaics and last year's inauguration of the world's first large-scale power station equipped with carbon capture and sequestration technology, clearly indicate there is significant and untapped potential for accelerating R&D on clean technologies.

The IEA report echoes much of what ATSE has advocated recently in its Energy Position Statements and Action Statements, which are available online at [Subjects > Energy > Position and Action Statements](#).

ENERGY WHITE PAPER TARGETS COMPETITION

The Australian Government's Energy White Paper, released in April, will deliver competitively priced and reliable energy supplies by promoting competition in energy markets, increasing energy productivity and facilitating investment in energy resources development, according to Industry and Science Minister Ian Macfarlane.

"The measures in the Energy White Paper will deliver stable energy policy and efficient transparent markets that give consumers information to make choices about their energy use and industry the confidence to invest," Mr Macfarlane said.

"The National Energy Productivity Plan will deliver up to 40 per cent improvement in energy productivity, reducing household and business energy costs, encouraging economic growth, as well as helping to reduce emissions.

"The productivity target will be developed as part of Australia's post-2020 emissions reduction target, which we will take to the United Nations Framework Convention on Climate Change this year.

"In addition to energy market reforms that give consumers information to manage their energy use, the National Energy Productivity Plan will promote more efficient buildings, transport, and equipment and appliances."

Mr Macfarlane said the Energy White Paper would provide a framework for coherent and consistent energy policy that would enable the integration of other related policies as they are developed. "For example, given Australia's energy sector contributes a large proportion of our greenhouse gas emissions, Australia's emissions reduction target after 2020 will link closely with energy-related reductions.

"The development of our emissions reduction policies will build on the framework in the White Paper, to enable flexible policy development."

The Energy White Paper is available at www.ewp.industry.gov.au.

NEW APPROACH TO MAKING HYDROGEN

University of NSW scientists have developed a highly efficient oxygen-producing electrode for splitting water that has the potential to be scaled up for industrial production of the clean energy fuel hydrogen.

The new technology is based on an inexpensive, specially coated foam material that lets the bubbles of oxygen escape quickly.

"Our electrode is the most efficient oxygen-producing electrode in alkaline electrolytes reported to date, to the best of our knowledge," says Associate Professor Chuan Zhao, of the UNSW School of Chemistry.

"It is inexpensive, sturdy and simple to make, and can potentially be scaled up for industrial application of water splitting."

The research, by Associate Professor Zhao and Dr Xunyu Lu, was published in the journal *Nature Communications*.

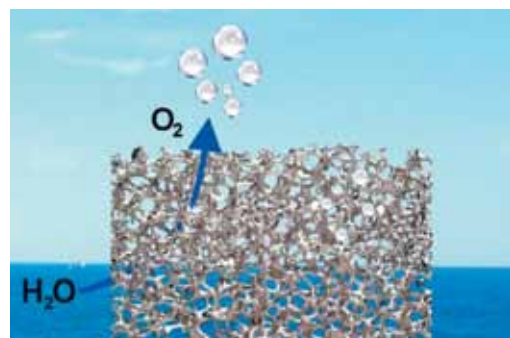
Inefficient and costly oxygen-producing electrodes are one of the major barriers to the widespread commercial production of hydrogen by electrolysis, where water is split into hydrogen and oxygen using an electrical current.

Unlike other water electrolyzers that use precious metals as catalysts, the new UNSW electrode is made entirely from two non-precious and abundant metals – nickel and iron.

Commercially available nickel foam, which has holes in it about 200 micrometres across, or twice the diameter of a human hair, is electroplated with a highly active nickel-iron catalyst, which reduces the amount of costly electricity needed for the water-splitting to occur.

This ultra-thin layer of a nickel-iron composite also has tiny pores in it, about 50 nanometres across.

Hydrogen production is a rapidly growing industry, but the majority of hydrogen is still produced using fossil fuels such as natural gas, oil and coal, because this approach is still cheaper than electrolysis of water.



An artist's impression of the water-splitting electrode.



The Green Chemical Futures building.

Monash opens its Green Chemical Futures hub

Monash University's recently opened Green Chemical Futures (GCF) building is a multidisciplinary innovation hub dedicated to supporting researchers and industries innovating within the chemicals manufacturing sector.

The new building acts as a catalyst for new ideas, providing a stimulating environment where industry and academia collaborate. The design of the building itself is intended to stimulate innovation, with features such as a spiralling staircase and inspiring wall art.

The first two levels of the building house innovative teaching and collaborative learning spaces, encouraging active learning and creative problem-solving. The building also includes top-class research laboratories and facilities on the upper levels.

Also in the building is the Victorian Centre for Sustainable Chemical Manufacturing, the Graduate Research Interdisciplinary Program, and the Training and Innovation hub of the Chemicals and Plastics Innovation Network.

It was opened by Senator Scott Ryan, Parliamentary Secretary to the Minister for Education and Training.

Monash University President and Vice-Chancellor Professor Margaret Gardner AO said the building would connect industry with researchers and students. "As part of the second-largest manufacturing sector that employs more than 60,000 people in highly skilled jobs, chemistry is central to the country's societal, environmental and economic well-being," she said.

RESEARCH BOOST FOR PAINT-ON SOLAR CELLS

International venture capitalist Mr Alberto Chang-Rajii has invested \$1.5 million in a research partnership with UNSW engineers to commercialise a new generation of low-cost, high-efficiency solar cells that can be 'painted' onto building tiles, windows and car roofs.

Mr Chang-Rajii, who made the announcement while visiting UNSW in March, has 'form' with getting in early on 'game-changing' technologies. While completing his MBA at Stanford University in the mid-1990s, he scraped together \$10,000 to purchase one per cent of a start-up called Google. His share in the internet giant is today worth an estimated US\$3.74 billion.

A career venture capitalist, he now operates a global private equity firm Grupo Arcano, based in Chile. The firm invests in energy, technology and financial services companies, and in 2014 it expanded its operations to Australia, where Mr Chang-Rajii says he plans to invest upwards of \$100 million over the next two years.

His first Australian investment is a \$1.5 million research partnership with a team of photovoltaic (PV) engineers from UNSW, through a spin-out company called Future Solar Technologies.

The research, which is led by UNSW engineer Dr Ashraf Uddin, is developing next-generation solar cells made not from silicon, but from hybrid perovskites.

In the past two years this material has taken the global PV research community by storm. *Nature Materials* said hybrid perovskite was "exceptionally promising" and "may revolutionise the field of renewable energy", while *MIT Technology Review* said it could offer "dirt cheap" solar power.

Dr Uddin says his team is targeting greater than 20 per cent conversion efficiency rates for its cells within three years – more or less on par with mass-produced silicon solar cells. While the lifespan of these solar cells is shorter, they offer some advantages over conventional rooftop panels. They are significantly thinner, lighter and more flexible, which means they can be easily applied to a range of different surfaces, such as exterior walls and windows, transport vehicles and even mobile phones.

"You can laminate a two-bedroom house so it becomes a zero-energy house, and it would only cost about \$2000," Dr Uddin told *The Australian Financial Review*.

The Chilean investor was drawn to UNSW because of the stellar reputation of Professor Martin Green FRS FAA FTSE, often referred to as the 'father of photovoltaics'.

UNSW has granted Mr Chang-Rajii and Future Solar Technologies a free licence for the patent that already existed, as well as free access to any patents that are subsequently filed by the same research group.

Mr Chang-Rajii says his investment firm often collaborates with universities because "it's where you get the brightest minds, the best projects, and the lack of funding, so it's where we can be of assistance".

The venture capitalist has a very good track record. His three most recent investments were with high-profile companies including the electronic payment system Square, the photo messaging app Snapchat, and the taxi-replacement app Uber.

PHOTO: ROBERT LARGENT



Ashraf Uddin with a hybrid perovskite solar cell.

Sensors to extend pipeline life

Three new research projects at Deakin University, funded by Australia's energy pipeline industry, aim to develop a world-first pipeline health monitoring system to be based on a high-tech sensor developed by Deakin researchers.

The Deakin Corrosion Research Centre has been granted about \$1 million by the Energy Pipelines CRC to progress the sensor technology through a three-year development phase prior to commercialisation.

Many of the pipes in Australia's multi-billion-dollar oil and gas industries are near the end of their 30 to 40-year design timeframe, but replacement means massive difficulty and expense.

"High-pressure underground pipelines are typically protected against corrosion by a combination of barrier coatings and cathodic protection systems," says Co-Director of the Deakin Corrosion Research Centre, Professor Mike Tan. "When their coatings become 'disbonded', due to the effects of various chemical, electrochemical, electrical and environmental factors, pipelines become susceptible to corrosion that can eventually lead to leaks or catastrophic failure."



Monitoring pipeline health.

Professor Tan explained a common method of detecting corrosion is 'smart pigging', where a testing device (known as a pig) is inserted into the pipe and carried along by the fluid flow. However, this is expensive and is usually only carried out at intervals of at least five years.

"The sensors will play an important role in complementing that technique, with a focus on the outside of the pipes, where most of the underground pipeline corrosion tends to occur," he says.

The sensors would provide continuous, real-time monitoring of the efficiency of cathodic protection, coatings and corrosion and enable the modelling and prediction of when and where corrosion damage would likely occur, resulting in more efficient maintenance and cost savings. The sensors would use wireless or satellite technology to alert companies when issues occurred and could be designed to be suitable for oil and gas pipelines, underwater pipes, desalination plants, bridges, large structures and submarines.

INCAT'S LATEST SHIP GOES TO JAPAN

Akane, an 85-metre high-speed Wave Piercing Catamaran Ferry from Tasmanian shipbuilder Incat, has started service on the west coast of Japan, operating for Sado Kisen, a long-standing ferry operator.

Akane is Sado Kisen's first high-speed passenger/car carrier, with a capacity of 692 persons and up to 151 cars.

Incat Chairman Robert Clifford said: "Akane is Incat's third delivery to Japan and we are pleased to see the increasing interest in high-speed vessels from this part of the world."

The main passenger and forward executive areas offer tourist- and business-class seating and the vessel's interior fit-out includes a shop and



Akane under way.

information desk, first-aid room, children's play area and pet room.

With a beam of 26 metres, the ship achieved over 37 knots loaded with 470 tonnes during sea trials and can operate at about 40 knots with 200 tonnes. It is powered by four Caterpillar C280-16 marine diesel engines driving four transom-mounted steerable waterjets.

NAVAL SHIPBUILDING DEPENDS ON REFORM

The sustainability and viability of naval shipbuilding in Australia must be predicated on major reform of the industry and significant productivity improvements, as well as improvements to Defence's acquisition and sustainment processes, according to a report prepared for the Government by the RAND Corporation, one of the world's leading defence think-tanks.

Key findings included:

- Australia could sustain a naval shipbuilding industrial base by carefully managing a continuous shipbuilding strategy in the longer term, with a regular pace of new ship delivery;
- this would require reform of the Australian naval shipbuilding industry and significant improvement in productivity;
- Australian naval shipbuilders could sustain an 18-to-24-month pace of large ship construction starts if the Department of Defence carefully managed its acquisition program and kept the Future Frigates operational for 25 to 30 years; and
- the gap between the completion of the Air Warfare Destroyer project and the start of the Future Frigate program could not be overcome, but the impact could be lessened.

The RAND report – *Australia's Naval Shipbuilding Enterprise – preparing for the 21st century* – is one of the most detailed studies undertaken into the Australian naval shipbuilding industry.

It found that Australia is currently one of the most expensive places to build naval vessels – 30 to 40 per cent greater than US benchmarks, and even greater against some other naval shipbuilding nations.

It said this could be addressed by improved productivity through:

- establishing a consistent production and build demand;
- selecting a mature design at the start of the build and limiting the amount of changes once production began;
- ensuring a well-integrated designer, builder and supplier team;
- matching the industrial base structure to demand; and
- ensuring there was visionary leadership by company management.



Creating the airports of the future

Queensland University of Technology is at the global forefront of airport R&D, spearheading international research to make airport experiences safer and faster – based on research in its Airport Innovation Research (AIR) Lab and People and Systems (PAS) Lab – where it says the world's future airports are being created.

"Our AIR lab runs many of the same systems a functioning airport does, including a check-in counter, security gate and command and control systems – it's just missing the runway," says Professor Prasad Yarlagadda, a smart systems expert who leads QUT's multidisciplinary airports R&D team.

For more than a decade QUT has been helping Brisbane Airport Corporation and other airports around the country through airport-related R&D and it claims the results are proving a game-changer for airports.

Professor Yarlagadda says the university built the AIR Lab to test its research because airports never sleep, which makes it difficult to conduct on-site testing without disrupting an airport's day-to-day business.

Video analytics software uses CCTV feeds to not just spot people posing a potential security risk but to monitor how quickly passengers move through the airport.

"The video analytics tracks the overall flow and throughput of passengers through an airport – the time it takes for them to go from A to B to C – identifying bottlenecks and other issues that are slowing down arrival and departure processes," says artificial intelligence and image processing specialist Professor Clinton Fookes.

"Currently, many staff make resourcing decisions based on their own perception of the airport's status, gut feeling and limited data feeds. These video analytics gives them the real-time data they need to make the best decisions for both passengers and staff.

"Combined with our statistical modelling software, this technology provides an unprecedented level of business intelligence to help the various airport agencies make sure your airport experience runs as smoothly as possible. And, more importantly, when it isn't running smoothly, this technology helps airport staff to detect that, and to understand why."

That statistical modelling software takes the massive amount of data traditionally collected by various airport sections and displays it in

Planning the airports of the future.

a way that shows how the work in one area impacts on others. It allows staff to predict the impact of a particular decision or event, identify the root cause of a particular issue and calculate which factors influence a particular outcome an airport is striving for.

"If, for example, an aircraft is going to arrive either early or late, the airport and border agencies can find out what impact that will have on their workload and can better adjust their resources to meet the changes in demand when they need to," Professor Fookes says.

QUT design research experts in the PAS Lab are using unique passenger-focused research to change the design and operation of airport security points.

Research recommendations from the PAS Lab team, led by Professor Vesna Popovic, have ensured passengers departing from Brisbane Airport now pass through security screening 80 per cent faster.

"Providing space for passengers before and after screening has allowed passengers to unpack baggage well in advance of screening, and sufficient time to re-pack so as not to crowd the conveyer belt," Professor Popovic says.

"Having personnel help passengers in these processes also speeds things up because people typically don't read signs at this point in their airport journey.

"These simple measures have lowered the airport's operational costs by 20 per cent because there has been an increase in passenger throughput from 260 passengers and hour to 340 an hour.



Seeing how the passenger sees the airport.

strategies both experienced and novice screeners use when checking baggage to help the novice staff get up to speed quickly, and have discovered that putting security screeners on a 10-minute rotation maximised their concentration levels.

"This monitoring will provide new knowledge and techniques to enhance security operator performance, refine the screening process, improve passenger experience and, most critically, ensure safety at our airports," Professor Popovic says.

QUT researchers are also using Tobii eye-tracking glasses to understand exactly what passengers look at and focus on while moving through airport terminals to help make navigating airports more intuitive.

"The less time passengers spend being lost and confused the better their airport experience will be," says industrial design researcher Andrew Cave. "One aspect to this project is ensuring passengers get to their boarding gate on time, because delayed flights due to missing passengers can be costly for airlines, airports and passengers alike."

"PAS Lab researchers are using eye-tracking technology for two separate projects: security screening and intuitive navigation at the airports.

"We've also identified the different

By Ian Rae
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An uphill trail in the maths of rocks

A trail leads from E. Sherborn Hills' *Outlines of Structural Geology* (1965 and 1972) through *An Outline of Structural Geology* (Hobbs, Means, Williams, 1976) and a couple of books on computation by the present authors, to this heavy volume.

It's an uphill trail, along which the terrain grows more and more mathematical, reflecting developments in the subject that is now treated in fractals, differential equations, eigenvectors, matrix algebra and tensors.

This sets the book apart from standard

undergraduate texts with similar titles, such as *Structural Geology of Rocks and Regions* (Davis, Reynolds, Kluth), to name one that is now in its third edition (2012).

The authors are Professor Bruce Hobbs AO FAA FTSE, former Deputy Chief Executive of CSIRO's Division of Minerals and Energy and former WA Chief Scientist Professor Alison Ord FTSE, Chair of ATSE's Mineral Resources Forum.

In this book they develop the relevant mathematics to describe the forces acting on the rocks and apply

them to deformation, fluid flow, thermal transport and mineral reactions (including nucleation processes and phase changes).

"Metamorphic systems," they write, "are considered to be giant chemical reactors that operate under non-equilibrium conditions and are driven by the kinematic boundary conditions arising from motions in the mantle of the Earth, the dead weight load exerted by overlying rocks and by the influx of heat and fluids such as H₂O and CO₂."

The results of modelling are

RICHARD LARKINS: A LIFE IN TWO PARTS

Louis Matheson, the first Vice-Chancellor of Monash University, used to tell the story of the Vice-Chancellor who earned a posthumous place at the University of Hell. At the time of his first appraisal he noted that he had a nice office, an efficient secretary and not much to do. 'How could this be Hell?' he asked. 'Ah,' said the Devil, 'you haven't discovered yet that this university has two medical schools.'

As Vice-Chancellor, Professor Richard Larkins AO FTSE apparently had no trouble with the Faculty of Medicine at Monash, but he had earlier encountered public hostility to the profession when he served on a Committee of Inquiry into Medical Education and the Workforce.

It wasn't just the public either, because "the discipline of medicine is always regarded with suspicion by other faculties in universities, particularly by the humanities and social sciences". Even at home in his Faculty a medical dean had to confront the "complex and troublesome" relationship between the university medical school and its affiliated research institutes. Life wasn't meant to be easy but it could be very rewarding.

The first part of the book recounts his education, his determination to pursue clinical work alongside teaching and research in endocrinology and eventually his chair at the Royal Melbourne Hospital.

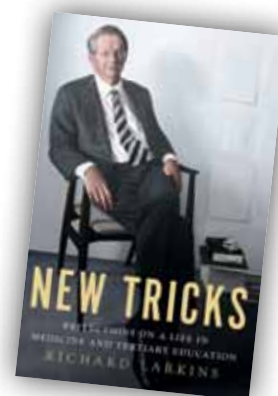
The peak came with his appointment in 1998 as Dean of the Faculty of Medicine and Health Sciences at the University of Melbourne. The Byzantine workings of this sector of the medical profession form a background to specific struggles in which he became involved, such as the imposition of a casemix funding model on hospitals by government in the 1990s.

On the university front, traditionalists resisted the introduction of problem-based learning (PBL) and graduate entry, both of which were adopted after suitable compromise. This is the life of a thoughtful and articulate insider whose leadership credentials soon found him favoured for senior appointments in the university and the profession.

In the second half of the book we meet Richard Larkins taking on the challenge of improving the Monash research performance, which had suffered from disruption and the waning of the original stars that had carried Monash so far in its early days.

This other Larkins was the travelling Vice-Chancellor who led the work to make all those offshore campuses active and at least non-loss-making, if not profitable. He devotes a chapter to each of them, giving much credit to his colleagues and taking pride in having assembled a great team.

Although the satellites were exempt, the faculties were subject to strategic cost



New Tricks: Reflections on a life in medicine and tertiary education by Richard Larkins (Monash University Publishing, 2015, viii + 264pp, \$39.95).

management (SCM), under which their activities were costed, meaning they paid for space and services. This approach revealed formerly hidden cross-subsidisation both within and between faculties and enabled rational decisions to be made about what to prune and what was valuable enough to merit subsidisation.

Apart from the offshore campuses, legacy of the Logan years at Monash, much of what happened to university governance in the first decade of this century was system-wide.

I can recommend Larkins' account to others who, like me, left before the hard years but still retain an interest.

— IAN RAE FTSE

presented in elegant, multi-coloured diagrams, often juxtaposed with macro- and micro-photographic exemplars, mainly of Australian metamorphic rocks. The eigenvector diagrams in muted but striking colours are worthy of the science-in-art prize.

In a field of science that brings together many components, from applied mathematics, physics, geology and chemistry – Hobbs referred to it in 1976 as materials science – the authors look forward to “an exciting future in detailed microstructural and microchemical studies that examine and test models for coupled diffusion systems” and assess their impact on mineral equilibria and phase boundaries.

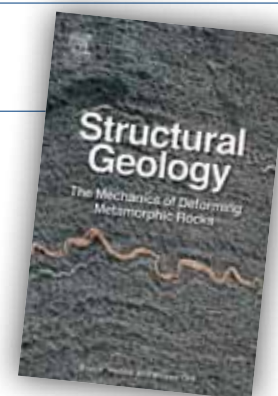
No doubt we’ll find a lot of this in Volume 2, where the authors plan to build

on the framework and vocabulary they have developed in their first volume.

While the table of contents is brief, each of the 15 chapters opens with an outline that helps the reader to navigate the text, and there is an excellent index. Chapters also include ‘recommended additional reading’, an admonition consistent with the fact that this is a serious book that could leave the unprepared reader struggling.

The reference list, with approximately 1000 entries, reinforces the view that this is a research monograph, not an undergraduate text.

Structural geology is strongly represented in Australian universities and in mineral exploration and development companies, where the publication of the book will be welcomed.



Structural Geology: the Mechanics of Deforming Metamorphic Rocks. Volume 1: Principles by Bruce Hobbs and Alison Ord (Elsevier, 2015. xiii + 665pp).

PROFESSOR IAN RAE FTSE, an Honorary Professorial 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 has served for more than a decade as a technical adviser to the UN Environment Program.

OUR CITIES ARE BROKEN: CAN WE FIX THEM?

Over the past five years the Grattan Institute, based in Melbourne, conducted 10 studies covering many aspects of Australian cities.

These studies are accessible at www.grattan.edu.au and the present volume draws on them to frame the book under three headings: the economy, opportunity and fairness, and social connections. Along the way it concentrates on housing and transport and shows how these are linked to jobs, lifestyles and social status. Much of the material has been taken up by journalists and otherwise appeared in the media, so many of the instances will be familiar to Fellows.

Putting them together in a book allows in-depth coverage and a certain amount of repetition to drive home the messages, but these are not new messages.

We are reminded that Melbourne, Sydney and Brisbane are Balkanized (my term – the authors prefer “divided”) cities. Most professionals live in inner suburbs that have good access to a range of jobs. Housing – both for ownership and rental – is in short supply, property values are consequently high, and the housing stock is inappropriate for many potential residents.

‘Local parochialism’ resists attempts at densification, thereby preserving community homogeneity and, incidentally(?), property values. These hegemonies are maintained by negative gearing and generous taxation

treatment of superannuation in the inner suburban republics.

New housing is built on the outskirts where there are few jobs except for those employed in service industries, such as schools, supermarkets and hairdressing. Other workers face long commutes.

Many people spend three or four hours getting to and from work, leaving little time for family life, let alone community and sporting involvements. And a dearth of public transport means that those hours are mostly spent in the car. Residents of a suburb like Point Cook in Melbourne’s south-west can take an hour to get onto an already-overcrowded main road or to the new railway station, where the carpark fills up soon after 7.00 am.

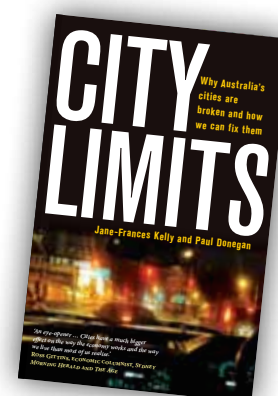
So, what can be done? As well as making the taxation system fairer, Kelly and Donegan call for more sympathetic planning and building regulations and for longer rental contracts to minimise family disruption. They also propose a range of fiscal measures to redress the balance.

These include differential tolls to spread traffic loads, congestion charges and the replacement of stamp duty (paid once) with land tax (paid annually), with the proceeds devoted to improved public transport.

Introducing such changes requires leaders who will face up to the challenges in our cities. Too often our leaders duck these challenges.

The authors suggest several reasons: failure to grasp the realities of city living that are so different from those they grew up with or those they face in the safe havens where they live and work; and pursuit of easy answers that don’t solve problems, but being short term in nature can help them win the next election.

“The challenge is not just one for governments though. Our cities will only get better if we want them to”, the authors conclude. There is no single ‘we’, however, as the material they present makes clear, and their advice as to what ‘we’ can do is not explicit. – IAN RAE FTSE



City Limits: Why Australia's cities are broken and how we can fix them by Jane-Francis Kelly and Paul Donegan (Melbourne University Press, 2015, 218pp. RRP Print \$32.99, eBook \$19.99).

By Ian Rae
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The campaign to honour Monash

This is a book of an author who writes with a purpose – to have Monash posthumously raised to the five-star rank of Field Marshal. The Honourable Tim Fischer AC FTSE is a Honorary Fellow of the Academy, a former Deputy Prime Minister, accomplished author and much else besides.

The book opens with a selection of the praise heaped on Monash by other authors, then a long list of “Australians who served at Gallipoli and who post-World War One went on to contribute much to the fabric of the Australian nation”, and finally a dedication to the 414 chaplains of the Australian Imperial Force. It’s a fuzzy introduction that gets in the way of the main story.

That story begins with the arrival of Monash’s father, Louis Monasch, from Prussia in 1854. It moves swiftly so that two-and-a-half chapters later we are with the Second AIF convoy leaving Melbourne in December 1914. Six more chapters bring us to the end of the Great War, and the following nine are devoted to an analysis of what has gone before and a little about Monash’s post-war career.

The author tells his story well, drawing on the extensive biographies of Monash by Geoffrey Serle and Roland Perry and

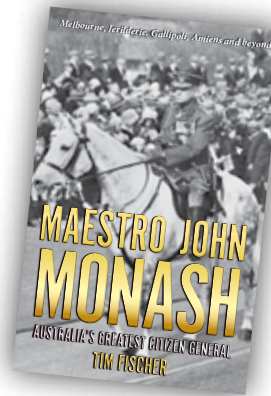
detailing battles in which Monash played decisive roles and some in which he made mistakes.

Yes, it’s ‘warts and all’ and includes notes about his references to mistresses Lizette, Annie and “probably others”.

The book is well-produced and the colour plates include a couple of battlefield plans, several Monash bridges and the bronze statue of general and horse that is situated near the Shrine of Remembrance in Melbourne. It’s a serious work with an excellent index and a couple of pages devoted to a select reference list.

For a number of reasons, and anti-Semitism was no doubt one of them, Monash was never a favourite of the military establishment and the news media. As a consequence, promotion came only slowly. Mr Fischer places major blame for this on the character of Monash as portrayed by war correspondent, later historian, C.E.W. Bean and reporter Keith Murdoch, and the active dislike of Prime Minister W.M. (Billy) Hughes. Seven decades of neglect by the Australian War Memorial hasn’t helped either.

Monash was promoted to three-star (Lieutenant General) rank at war’s end in 1918. The next step had to await the defeat



Maestro John Monash: Australia's Greatest Citizen General by Tim Fischer (Monash University Publishing, 2014; xxxiii + 268pp, \$29.95).

of Hughes’ party at a general election in late 1929 and his replacement as Prime Minister by Scullin, who almost immediately promoted Monash and Harry

Chauvel to four-star General rank.

Chauvel was still serving, but Monash had retired from the army and lived for less than two years to enjoy his new rank.

Mr Fischer’s proposal is that Monash should be posthumously elevated to five-star (Field Marshall) rank, back-dated to 11 November 1930, the first anniversary of his last promotion. Last year the South Australian Branch of the RSL passed a resolution in favour of posthumous promotion, and the period 2015–18 seems a propitious one in which a broader petition might succeed. “Make contact with our local federal MP and also with senators from your State or territory ... (if you wish) ... to be involved in the cause of recalibrating the designation of Monash”, writes Mr Fischer. By way of precedent he cites the promotion of Thomas Blamey to Field Marshall in the mid-1950s, with the appointment back-dated to 1 January 1946. Blamey, long retired, was retrospectively placed on active service for one day so that the promotion could proceed.

The arguments in the book lead directly to his giving us a pro-forma letter we might care to use if we join the campaign. It begins “As a salute to all members of the AIF in World War I and as a salute to Australia’s greatest general and an extraordinary citizen”.

Historians have identified growing interest in Australia’s military involvements, as evidence the tourist flood at Gallipoli and the recovery of biological material and artifacts at Fromelles.

The extended commemorations of the Great War will heighten that interest and some fear it could feed a growing militarism, but there is no doubt that an attempt to further honour John Monash will have its best chance of success in the next few years.

Good timing is vital in battle: Tim Fischer has chosen his moment well.

SEVEN PATTERNS OF CHANGE

In a new book from CSIRO Publishing, *Global Megatrends: Seven Patterns of Change Shaping Our Future*, author Dr Stefan Hajkowitz identifies seven patterns to tell a story about how the world will change over the next 20 years. The seven patterns outlined in the book are:

- More from less – increasing demand for and scarcity of limited natural resources;
- Going, going ... gone? – a window of opportunity to protect biodiversity, habitats and the global climate;
- The Silk Highway – rapid economic growth and urbanisation in Asia and the developing world;
- Forever young – an ageing population, chronic illness and rising healthcare expenditure;
- Virtually here – digital technology reshaping retail and office precincts, city design and function and labour markets;
- Great expectations – consumer expectations of services, experiences and social interaction;
- An imperative to innovate – technological advancement is accelerating, creating new markets and extinguishing existing ones.

ATSE IN FOCUS

Scott Sloan joins Royal Society

Laureate Professor Scott Sloan FRS FTSE, a geotechnical engineer, has been elected to The Royal Society: a fellowship of the world's most eminent scientific minds and the oldest scientific academy in continuous existence.

"I'm thrilled at the news," Professor Sloan said. "It's not that common for engineers to be elected as Fellows of the Royal Society."

Only four Australians were among the 47 new fellows and 10 new Foreign Members announced by the Royal Society in 2015 – a psycholinguist, an animal geneticist, an earth scientist and Professor Sloan.

He is a pioneer of new methods that enable engineers to predict the collapse states of geostructures such as tunnels, dams, highways and foundations, which have delivered a new tool for engineers to design cheaper and safer civil infrastructure across the globe.

Professor Sloan joins distinguished company, including 80 Nobel Laureates among the 1600 Fellows of the Royal Society, since its inception in 1660.

"My election is a reflection of the quality of the research work in geotechnical engineering that has been achieved at the University of Newcastle over the past 30 years. The geotechnical team at Newcastle is a world-leader in its field and is home to a number of outstanding researchers of all ages," Professor Sloan said.

Professor Sloan studied for his BEng and MEngSci Degrees at Monash University. He won a scholarship from Trinity College to undertake a PhD at the University of Cambridge in 1978. He later won a Rouse Ball Scholarship at Trinity College, which he held for a year. After three years as a WW Spooner Fellow at New College Oxford, he returned to Australia in 1984 to take up a lectureship in Civil Engineering at the University of Newcastle.

Professor Sloan was appointed Director of the 70-strong University of Newcastle Priority Research Centre for Geotechnical

and Materials Modelling in 2007 and made a Laureate Professor in 2008. He is also the founding Director of the Australian Research Council (ARC) Centre of Excellence for Geotechnical Science and Engineering, which is headquartered at the University of Newcastle. The \$24 million centre includes some of the world's leading geotechnical researchers and is focused on the development of more cost-efficient design procedures for roads, railways, ports, tunnels, pipelines, mining operations, and offshore oil and gas facilities.

A prolific researcher, Professor Sloan has published more than 340 refereed papers and delivered more than 40 plenary, keynote and invited papers at conferences. He accumulates in excess of 600 Scopus citations per year, which places him amongst the elite of geotechnical innovators and at the forefront of research in geomechanics.

Twenty-one ATSE Fellows are also Fellows of the Royal Society, as are one of the Academy's Foreign Fellow and two Honorary Fellows.

THIRTY-FIVE ATTEND NORTON JACKSON FORUM

The SA Division held its 2015 Norton Jackson New Fellows Forum at the Adelaide Science Exchange, attended by 35 Fellows and friends, to hear presentations from new Fellows.

Mr Jim Hallion FTSE made a presentation on his new role as Coordinator-General in South Australia.

Professor Göran Roos FTSE presented on *Why the production of complex things is critical to retain our present standard of living*; Professor Geoff Fincher FTSE spoke on *Plant cell walls: from biofuels to human health*; and Professor



Göran Roos

Craig Simmons FTSE addressed the topic *Groundwater: reflections, opportunities and priorities*.



Alex Zelinsky

ALEX ZELINSKY WINS SARGENT MEDAL

Dr Alex Zelinsky FTSE, CEO of the Defence Science and Technology Organisation, has won Engineers Australia's 2015 M A Sargent Medal, which will be presented in August.

The M A Sargent Medal is a long-established and prestigious award made by the Colleges of Electrical Engineering and Information, Telecommunications and Electronic Engineering.

It is named in honour of Dr Michael Anthony (Mike) Sargent AM FTSE, an outstanding Australian electrical engineer and President of the Institution of Engineers, Australia (1990).

The M A Sargent Medal consists of a bronze medal and certificate.

Numerous Academy Fellows have won the medal: Dr John O'Sullivan FTSE (2013), Dr Trevor Bird FTSE (2012), Dr David Skellern FTSE (2010), Dr Barry Inglis FTSE (2006), Emeritus Professor Henry D'Assumpcao FTSE (2003), Professor Brian Anderson AO FRS FTSE (2002), Professor Mark Sceats FTSE (2000), Professor Mike Miller AO FTSE (1999), Ms Else Shepherd AM FTSE (1996), Professor Rod Tucker OAM FAA FTSE (1995), Professor Martin Green AM FRS FAA FTSE (1994), Dr John Edwards FTSE (deceased, 1993), Dr John Ness FTSE (1991) and Professor Graham Goodwin FRS FAA FTSE (1990).

ATSE IN FOCUS

Keith Bullock: from engineering to hybrids

Emeritus Professor Keith Bullock FTSE, a former Dean of Engineering at the University of Queensland, was the first person to undertake a PhD in Engineering at UQ, graduating in 1957.

After gaining his PhD and winning a Fulbright Postdoctoral Fellowship, he was appointed Research Fellow and Lecturer at Harvard University, which led to a long-term collaboration with eminent Harvard scientists in the Division of Applied Physics and Engineering and to frequent return appointments to Harvard University as a Visiting Professor.

His early work for the sugar milling industry contributed to putting Australian mill technology ahead of overseas competitors, with the doubling and – in some cases – trebling of mill capacity through modifications to driving motors and feeding arrangements.

An advocate for increasing the number of women in engineering, he was Head of the Department of Mechanical Engineering (1975–82) and Dean of the Faculty of Engineering (now the Faculty of Engineering, Architecture and Information Technology) (1983–88).



Keith Bullock

Since his early retirement from UQ in 1991, he operated his own business – Transport Energy Systems – to develop and evaluate his innovative technology for hybrid vehicles.

The TES technology has been awarded

patents in numerous countries. The excellence of his scientific contributions to hybrid technology has attracted several awards, including the Rodda Award for outstanding work on a multi-purpose hybrid vehicle, the Batchelor Award and an (SAE) Australasian Excellence Award.

Professor Bullock died in Brisbane in March, aged 84.

He was a Fellow of Engineers Australia, and Member of the American Society of Mechanical Engineering and the Society of Automotive Engineers of Australasia.

His wife, Professor Margaret Bullock AM FTSE, is renowned in the areas of ergonomics and physiotherapy. She was one of the first two people in Australia to receive a degree in physiotherapy, graduating from UQ in 1955.

In 1974, she became the first Australian to be awarded a PhD in physiotherapy and was Head of UQ's Department of Physiotherapy for 14 years, before serving as President of the Academic Board (1988–90). She was Dean and Head of UQ's School of Health and Rehabilitation Sciences from 1996 until her retirement in late 1998.

"FORESIGHT, CREATIVITY, TENACITY, INTEGRITY"



John Simmons

Professor John Simmons AM FTSE, himself a former Dean of Engineering at UQ, delivered a heartfelt eulogy at Keith Bullock's funeral in Brisbane. This is an edited version.

Keith Bullock was an engineer and academic of extraordinary foresight, creativity, tenacity and integrity and understanding of mechanical engineering who had a profound influence on the careers of many colleagues and students.

Influenced by his long relationship with Harvard University, Keith had an enormous commitment to driving Mechanical Engineering at UQ into an era of world-class scholarship, he said.

Keith's prize-winning undergraduate

achievements were illustrious and he was the first to undertake a PhD in Engineering at UQ. His work on sugar mill design enabled sugar milling companies to optimise their production and triple the capacity of milling trains.

Professor Chris Greig FTSE, whose company designed sugar mills around the world, had said that Keith's design of nearly 60 years ago was still industry standard practice, Professor Simmons said.

"A lot happened in 1957. The PhD was awarded and Keith won a Fulbright Fellowship to the US. Margaret and Keith married and moved to Boston, where Keith was employed as a Lecturer and Research Fellow at Harvard University.

"So began a long and fruitful collaboration with eminent scholars from that prestigious institution. This was the harbinger of extraordinary developments in research in the Department of Mechanical Engineering at UQ.

"In 1960, Keith took up an academic

appointment at UQ. His influence on the Department's culture probably began with his introduction of research in the extremely challenging field of turbulent flow and heat transfer.

"This cutting-edge work required cutting-edge experimental equipment. Keith drove the introduction of state-of-the-art hot-wire anemometry, and the acquisition of advanced analogue computers and the revolutionary computer of the day, the hybrid computer, which alone had the speed to handle the mass of data generated in turbulent flow experiments.

"While the US aerospace establishment was pioneering hybrid computing on a multi-million-dollar scale, there was Keith with the vision and drive to go the same way and set up the most comprehensive computing facilities in any engineering department in Australia.

"Keith fulfilled his vision of hypersonic aerodynamics research at the University when

ATSE IN FOCUS

he convinced Ray Stalker (the late Professor Raymond Stalker AO FAA FTSE – see *Focus* 183) to leave ANU. He encouraged Ray to build world-leading shock tunnel facilities and to conduct the scramjet research that has spectacularly put Mechanical Engineering at UQ on the international stage.

"Throughout his career, Keith was committed to efficient use of energy in transport. We might not know what a hybrid computer was but we all now know what is meant by the term 'hybrid vehicle'.

"Keith formulated the concept way back in the late 1970s. That was when he began a major and unique program of research into energy management and fuel saving in hybrid vehicles, a program with substantial funding that he led ingeniously for nearly three decades. Keith never stopped thinking about it.

"The first project undertaken by Keith's new research group was the innovative design, construction, testing and demonstration of a hybrid Ford Falcon car that provided major fuel savings".

The hybrid car's proving run was to Mackay and back, Professor Simmons said, with a conventional back-up car as support for contingencies.

"It broke down; the hybrid car ran like clockwork. It is believed to be the first successful hybrid car in the world.

"The Japanese, in particular, were fascinated by Keith's design, which preceded their development of the Toyota Prius hybrid car by some years.

"After leaving the University in 1991 to start his own business, Transport Energy Systems, he applied his great intellect for many years to other mechanical systems – effective fuel-saving hybrid systems for heavy mining vehicles, freight rail locomotives, waste collection trucks, heavy highway trucks, city transit buses and remote-area power stations.

"While Head of Department and later, Dean of Engineering, Keith made huge contributions to the University's development.

"Universities are about developing ideas and people. Keith had more creative ideas than anyone I have known.

"I once told Keith that I felt I was being spread too thinly. 'John,' he said. 'It's all a matter of how thick you are to start with.' That profound remark has shut me up for 42 years.

"Keith was 'thick'; his drive and capacity seemed unlimited."



Michael McLaughlin knee-deep in his work.

Norman Borlaug Award to Michael McLaughlin

Professor Michael McLaughlin FAA FTSE, a CSIRO Science Fellow and a Research Professor in Soil Science at the Waite Campus of the University of Adelaide, is the 2015 IFA Norman Borlaug Award laureate.

Professor McLaughlin has more than 30 years' experience in soil fertility and plant nutrition research over more than three continents, starting first in Africa and then in Australia and south-east Asia.

His research now has a global impact and coverage through the establishment of The University of Adelaide Fertiliser Technology Research Centre.

Professor McLaughlin's research is characterised by a focus on the fundamental mechanisms of fertiliser behaviour in soils and linking these to field observations to improve fertiliser effectiveness.

Professor McLaughlin's research is also characterised by new methods used to examine fertiliser behaviour and effectiveness, such as isotope tracing and dilution methods to determine the fate of added fertiliser and to benchmark

improvements in crop nutrition effectiveness.

He is known as an effective communicator of his research. In response to farmer requests in 2006 for information on how to manage fertilisers during and after the drought, Professor McLaughlin and two colleagues quickly published a grower fact sheet detailing current scientific knowledge of nutrient management under drought conditions and recommendations for fertiliser management in the 2007 season.

The IFA (International Fertilizer Association), based in Paris, is a trade association representing the global fertiliser industry, with some 550 members in about 86 countries. IFA member companies represent all activities related to the production and distribution of every type of fertiliser, their raw materials and intermediates. IFA's membership also includes organisations involved in agronomic research and training.

The IFA created the IFA Norman Borlaug Award for research in 1993, which has led to significant advances in crop nutrition.

ATSE IN FOCUS

Six Fellows awarded RIAus Bragg status

One of the Academy's most senior Fellows, Dr Basil Hetzel AC FTSE, was one of six Fellows inducted into Bragg Membership of RIAus in Adelaide in April.

Dr Hetzel, who will turn 93 on 13 June, has been a Fellow since 1981 and is an internationally recognised medical researcher who has made a major contribution to combating iodine deficiency.

He is a Fullbright Scholar and former Foundation Professor of Social and Preventative Medicine at Monash University. He was later initial head of the CSIRO Division of Human Nutrition, Chancellor of the University of South Australia and SA Lieutenant Governor.

Bragg Membership is awarded to eminent Australian scientists the RIAus Council has determined have made a particularly significant contribution to their field of endeavour. Bragg Members are the only voting members of the Institution.

Professor Lynn Beazley AO FTSE, former WA Chief Scientist, was also named a Bragg Member of RIAus in April, along with Australian Chief Scientist Professor Ian Chubb AC FTSE, Dr Alan Finkel AO FTSE, Academy President and Chancellor of Monash University, Emeritus Professor Ian Lowe AO FTSE and Dr John O'Sullivan FTSE, a leader in the CSIRO wireless LAN team and a winner of the Clunies Ross Award, the CSIRO Chairman's Medal and the Prime Minister's Prize for Science.

Other Fellows who are Bragg Members include Professor Peter Andrews AO FTSE, Professor David Boger FRS FAA FTSE, Professor Graeme Clark AC FRS FAA FTSE, Dr Gregory Clark FTSE, Professor Adrienne Clarke AC FAA FTSE, Professor Ian Frazer AC FAA FTSE, Sir Rod Eddington AO FTSE, Professor Martin Green AM FRS FAA FTSE, Mr David Knox FTSE,



Lyn Beazley receives her Bragg Membership from the Duke of Kent.



Basil Hetzel



John O'Sullivan

Professor Tanya Monro FAA FTSE and Professor Sir Gustav Nossal AC CBE FRS FAA FTSE.

STAN SCHAEZEL: A LONG LIFE IN AERONAUTICS

Mr Stan Schaezel FTSE, a Fellow since 1977, was renowned in the Australian aeronautical industry for more than 50 years.

It started when he arrived in Australia in 1950, serving with the Government Aircraft Factories in the 1960s and later becoming Chief Designer and then Technical Director of Hawker de Havilland.

Mr Schaezel died in March in Sydney, aged 90.

Born in Poland, after completing one year of university studies in wartime France, he escaped in 1943 and joined the Polish Air Force in Britain.

He graduated from London University and then completed postgraduate studies in

aeronautics at Imperial College and before migrating to Australia in December 1950. He worked for 16 months for the Bristol Aeroplane Company and was involved in the design of the Brabazon and the Britannia aircraft.

He joined the Government Aircraft Factories in Melbourne in January 1951, where he worked initially on the Jindivik target drone project, then conducted the project design of Malkara guided missile and became its trials engineer. Malkara was one of the earliest anti-tank guided missiles, jointly developed by Australia and Britain.

In 1960 he was seconded for seven years to the Aeronautical Research Laboratories, where he headed the Missile Design Group on Ikara, the anti-submarine missile. He was one of the proposers and then the first Project Manager of Turana, developed from the Ikara, intended to provide a parachute-recoverable pilotless target for use in gunnery and missile defence training by the Royal Australian Navy.

Mr Schaezel joined Hawker de Havilland (HDH) in Sydney as Chief Designer in 1970 and was appointed to the Board in 1971 as Technical Director, in charge of all research, engineering and quality activities. In 1972 he was elected Fellow of the Royal Aeronautical Society in London.

He headed the HDH involvement in Interscan navigation systems and was active in the Coastal and Fisheries Protection area, when HDH was producing high speed aluminium patrol boats in the 1970s.

In 1980 was appointed Director of the emerging Australian Aircraft Consortium and acted as its Interim Chief Executive for

18 months. In 1982 he became Chairman and Managing Director of the first Australian company devoted purely to space activities, Auspace.



Stan Schaezel

In 1984 he was the proposer and convenor of the First National Space Symposium in Sydney.

He retired from HDH in 1989 and established his own consulting firm in 1990.

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