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- 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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Front cover: Technology is taking us to a new age.
PHOTO: iStockphoto



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

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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.

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By Denise Goldsworthy

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Katrina at ChemCentre examines soil columns to understand the use of mining industry byproducts as soil amendments for improved soil and waterway health.

We need to connect research with the mining industry

Research organisations should think and behave differently – connect the right solutions to the right problems – learn about the industry and understand current business drivers.

There is no disagreement about the important role that mining has in the current and future economic performance of Australia. To ensure its continued strong contribution, as well as to leverage the opportunities that flow through to the manufacturing and mining services industries, it is important to ensure that the Australian mining industry is at the forefront of adopting technology.

Underpinning recent changes in the Federal Budget is the belief that economic imperatives, such as falling productivity, should be sufficient to drive industry engagement with research.

Even though recent reports of global mining productivity indicate a 20 per cent decline (PWC, *Mining for Efficiency*, August 2014), anecdotally many of Australia's research organisations are indicating that engagement with the mining industry has fallen over recent years and, in some cases, stopped.

The resources sector is not alone, with poor collaboration on innovation

between industry and higher education or public research institutions, ranking Australia 33rd out of 33 in the OECD (Eurostat CIS 2010, June 2013).

With this ranking there is only opportunity. Can research organisations be proactive and change the nature of the relationships and engagement with the mining industry? I believe they can be – and should be – part of the solution.

At the heart of the opportunity is the need to connect the right solutions to the right problems, requiring a willingness of the researchers to learn about the industry and to understand their current business drivers:

- Increasing role of governance/compliance/legislation – increasing pressure to reduce risk and ensure everyone follows the rules. The system and cultural processes that support effective compliance are usually the opposite of those that support effective innovation. It is very difficult to be good at both;

- Increasing requirement to deliver in the short term – this timeframe being incompatible with longer-term research;
- Global companies centralise procurement for purchasing power and these practices tend to be inconsistent with diverse, scattered R&D being delivered by individuals, even if they are the best in the world; and
- Outsourcing expertise and risk fundamentally changes the systems and cultures – inhibiting internal innovation – and leads to structures where many companies now lack the expertise to oversee specialist science based R&D.

So what can be done?

There are two basic options:

- 1** Change the knowledge, systems and culture of the research organisations so they are more compatible to the changing needs of the industry; and/or
- 2** Select the companies that are likely to have a higher level of

engagement with innovation.

Starting with the second option, a company that is going to be open to innovation and therefore a good partner for R&D will have a few key characteristics:

- An entrepreneurial culture – a test is to find out if the organisation is prepared to recognise and reward failure; conditional recognition like ‘only if the lessons learnt are captured’ is still OK;
- Risk-management rather than risk-avoidance processes are inherent in the way the business operates – if the organisations are prepared to negotiate contracts fit for purpose and not impose ‘our’ template; and
- An open culture that promotes questioning and searching – find out how the business deals with bad news. If it is comfortable with passing bad news up the chain, then the organisation is unlikely to have a ‘blame’ culture that can shortcut and prevent the search for facts and data and scientific-based solutions.

In a practical sense there are four approaches to finding such companies:

1 Find the companies with the right mentality

Start-up companies usually have entrepreneurial cultures and risk-management systems, even if they are less formalised. Companies that are less than 15 years old but more than five years old will often still have the start-up mentality balanced with a quality check that the skills are good enough that the company can survive the real world.

2 Find the companies that comfortably ride the ups and downs of commodity cycles without headline reports in the media of massive redundancies

This implies they have inherent business systems that are flexible and based on risk management and they have engagement with the workforce and systems that support riding the waves. Many of these are SMEs and many are mining

services companies that structurally accept this reality as part of doing business. Beware those in the lowest quartile that are potentially running a business model of survival based purely on costs, and therefore don't have the systems or culture to support R&D.

3 Find the companies that are managed (CEO or other key roles) by entrepreneurial types

Or, in the case of mining, have an exploration background. Exploration – like R&D – is a game where the odds of success are low, and the efforts can be long before the occasional large reward.

4 Find the industries that have been forced to be innovative

Typically, look to the speeches and media releases by the mining majors who are focused on cost reduction. When you see statements like “We have put the pressure on our suppliers of x, y and z to reduce costs by double digit percentages, or we won't deal with them”, then the companies successfully responding to these requests, such as

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mining services and suppliers, are where the research organisations should look.

One downside of these types of companies is that they are less likely to have engaged with R&D before. They are also less likely to have large buckets of cash, and so are more likely to be looking to multi-stage processes that can give them quick wins (quick returns as well as regular injections of confidence boosting) and they will definitely be looking to hold their research partners accountable for delivering everything in the plan, on time and on budget.

This requires the research organisations to think and behave differently, which links to the first list of actions that can be taken to more effectively align research with business needs.

Be ready, willing and able to educate a new company to research on the framework processes and systems that go with your organisation – from ERA rankings and the need to publish, to explaining the academic requirements of selection and supervision of PhD projects.

Be prepared to be flexible in designing the approach to the research. Methods that allow for multi-step prototypes and pilots and high engagement with industry will have fundamentally shorter learning loops and better align with business needs and ensure that the solution stays aligned with the problem.

Be flexible in designing the approach to contracting and governance of the project. This includes being prepared to be held accountable, but equally hold them accountable for delivering their half of the conversation.

Remember that mining companies are about more than finding, processing and transporting rocks. Many of the issues they are facing are associated with other aspects of the business – Health Safety Environment (HSE), training and human performance, maintenance, energy and water supply, general infrastructure design, or efficient and effective ICT. Researchers in these disciplines may not have been looking to mining companies as potential clients, and may not know the jargon, so look to

cross-discipline or other collaborative arrangements to deliver the solution.

Establish a clear argument to differentiate your work from other research providers beyond the quality of the research. These are companies used to tendering and they need to know why they should pick your research team over any other. This includes aspects like the ability to work together and understand the mining company's issues, and flexible and fast contracting processes.

Successful implementation of a disruptive technology also requires more than an understanding of the science and technology.

The solution may be required to be implemented across multiple countries using multiple languages and in multiple regulatory environments. So be prepared to engage the social sciences, business and even the humanities in finding the sustainable package.

It all sounds very difficult, but fundamentally it is about good change management for which there is a nice

scientific parallel – activation energies of chemical reactions. There is a hump that must be overcome before a 'lower energy' – read more productive, effective or efficient – state can be reached.

So what are the catalysts that can help reduce this resistance and make it easier for the client? Find them, and you have a path that works.

MS DENISE GOLDSWORTHY FTSE is the founder of Alternate Futures Pty Ltd, a company that connects solutions to problems by addressing knowledge, cultural and system barriers, connecting research organisations, tech start-ups and industry. Prior to this, Ms Goldsworthy worked as an executive for Rio Tinto, with roles including Chief Commercial Officer, Autonomous Haul Trucks; Managing Director, Dampier Salt; and Managing Director, Hls melt. Named the 2010 Telstra Australian Business Woman of the Year, she is Chair of ChemCentre WA, is a member of the Edith Cowan University Council, is a trustee for the Navy Clearance Diver's Trust and was previously Director of Aquila Resources. She is Deputy Chair of ATSE's Mineral Resources Forum.

RESOURCE EXPORTS GROW 10 PER CENT

The volume of Australia's resources (mineral and fuels) exports grew more than 10 per cent in 2013 – almost double the annual rate of the last decade – according to Department of Foreign Affairs and Trade statistics.

The increase in volume showed the resources boom transitioning from the investment phase to the production phase as projects developed over recent years began operation. In 2013, higher volumes of iron ore and coal were the principal drivers of export growth.

DFAT's newly released *Composition of Trade, Australia 2013* also showed export values rose six per cent to \$318.5 billion. All major sectors including rural goods, minerals and fuels, manufacturers and services recorded export growth.

In 2013, China remained Australia's top trading partner, with two-way trade valued at \$150.9 billion. Trade with Japan was valued at \$70.8 billion, while trade with the US accounted for \$54.7 billion.

OTHER KEY POINTS ON EXPORTS INCLUDE:

- Iron ore rose 27.6 per cent to a record \$69.5 billion in 2013;
- Natural gas was up 8.8 per cent to \$14.6 billion;
- Other personal travel services (excluding education), which included short-term visitors' expenditure in Australia mainly for recreational purposes, rose eight per cent to \$13.1 billion;
- Aluminium ores rose 11.9 per cent to \$5.9 billion;
- Beef was up 19.8 per cent to \$5.7 billion; and
- Professional services rose 18.9 per cent to \$4.6 billion.

Exports of education-related travel services (which included foreign student expenditure on tuition fees and living expenses in Australia) rose for the first time in four years, by 3.8 per cent to \$15.0 billion.

A person is lying on their stomach on a pink surfboard, riding a wave. The sun is low on the horizon, creating a golden glow over the water and sky. The person's hair is blowing in the wind. The overall mood is serene and adventurous.

**We ask,
we seek,
we solve.**



By Shaun Gregory
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Woodside's North Rankin Complex on Australia's North West Shelf. The original platform (right), installed in the early 1980s, required innovation in foundation design. The additional platform was installed in 2013.

Oil and gas innovation: turning challenges into opportunities

Technology and innovation underpin success across the oil and gas industry value chain, driving unexpected discoveries, new methods of extraction, innovative developments and breakthroughs in getting products to market.

It's hard to believe that just over 50 years ago, Woodside was 'deepwater' drilling to world-record depths of 60 metres in Australia's Bass Strait. Today, drilling technology allows operators to tap into resources up to depths of three kilometres or more.

It's amazing to think how far the oil and gas industry's deepwater capabilities have evolved in a relatively short space of time.

What's clear is that technology and

innovation underpin success across the oil and gas industry value chain – driving unexpected discoveries, new methods of extraction, innovative developments and breakthroughs in getting products to market.

For the oil and gas explorers, advances in seismic technologies and supercomputers have resulted in discoveries of complex resources in locations that we would not have dreamed about even 10 years ago – unconventional onshore (reservoirs

that need to be encouraged to flow (via fracking), deepwater and ultra-deepwater.

Over the past 30 years, advances in seismic technologies have been nothing short of revolutionary – they have been driven by a need to better image the subsurface, especially in areas under salt, basalts, rough seafloor topography, and deeper at higher resolution.

Seismic imaging requires substantial computing power, but technological

**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

WHAT IS COFS?

COFS is headed by Winthrop Professor Mark Cassidy FTSE (see 'Innovation partnerships underpin offshore energy developments', ATSE Focus 180, October 2013, pages 20-21). Its researchers, consulting engineers and technical staff work to solve some of the key engineering challenges of today and tomorrow – on the mechanics of seabed sediments, offshore foundations systems, pipeline and deep water offshore engineering and geohazards – to support both the local and global engineering community.

advances in this area have not only enabled the imaging advances to occur but have also brought other data into the mix. Geochemical, drilling, fluid composition, detailed reservoir data, plate tectonics and many other data sets are now bringing previously separate disciplines together.

By 2020, the most advanced supercomputers are expected to be more than one million times more powerful than their equivalents in 1995. This seemingly unending advancement of computer power will continue to drive advancements in seismic imaging and integrating disciplines through techniques like full waveform inversion, where more accurate descriptions of the subsurface done in near real time are potentially on the horizon.

Extraction and development

Once we get to the extraction and development of resources phase, technology is allowing us to tap into those resources once considered 'stranded' or unattainable.

Coal seam gas (CSG) is a good example. We have known about this resource for a long time. However, it is only in recent years that advances in technology have allowed us to extract CSG, which now makes up a significant proportion of Australia's future natural gas production. In the next few years, again thanks to innovative engineering efforts, it will be exported as liquefied natural gas (LNG).

Meanwhile, in the US the industry has marvelled at the so-called 'shale gale' – a game-changer for the oil and gas industry worldwide. Just 15 years ago, US shale gas represented one per cent of US natural gas production and today, in large part thanks to advances in drilling and 'fracking' technologies, it represents about 35 per cent.

The best programs in the industry aimed at increasing efficiencies, reducing costs and enhancing operations' reliability are underpinned by a commitment to technology and innovation.

Amid increased competition for supply,

companies are focused on solutions that reduce risk, enhance profitability and establish themselves as a 'partner of choice'.

For instance, we know we can get more production, from more fields, into a smaller number of hubs, using long-distance tie-back technology such as subsea separation and boosting.

Most fields are within 300km of shore (the typical range of sediment flows when the reservoirs were formed from river outflows). The current industry records for gas tie-backs are about 200km and 70km for oil. The Woodside-operated Pluto LNG Project set a record for wellstream fluids tie-back distance to shore of 204km. But we expect that these records will continually be broken.

Woodside's gas platforms are also considered in the world's top five in terms of production output and reliability. But this achievement has not been without its challenges. In the 1980s and 1990s our engineers worked hard to solve issues related to foundation pilings on our platforms.

Woodside's approach

The pilings solution aptly illustrates Woodside's commitment to innovative problem-solving – it's been a key theme in the company's success over 60 years. We are very much a pioneering company and our approach has been – and continues to be – driven by our adoption of leading-edge technology.

Woodside has established a Technology Division, which is developing new in-house capabilities and ensuring we are leveraging off the very best service and technology providers. We are doing work on initiatives like construction-led design, subsea development, deepwater production systems and 'float-in' facilities.

Partnerships with other industry players and universities are central to our problem-solving approach. A great example is our connection with The University of Western Australia and the Centre for

Offshore Foundation Systems (COFS).

COFS evolved from the original research efforts in response to solving engineering challenges, including the pilings issues, in the foundations at two of our offshore platforms. Since its establishment in 1997, COFS has developed one of the most sophisticated research and modelling facilities in offshore geomechanics and engineering anywhere in the world.

COFS' work on the mechanics of seabed sediments, offshore foundations systems, pipeline and deep water offshore engineering and geohazards today provides support to the engineering community around the world.

Looking ahead

Looking ahead, it's hard to know exactly what the oil and gas industry's operations will look like in the future.

We do know that there is an increasing trend to doing more with less infrastructure. Already, Woodside has two platforms – Pluto and Angel – that can be remotely managed. I think it's safe to say that we can expect to see an increasing number of operations being controlled remotely.

This doesn't mean there won't be a role for humans. I expect that these operations will be remote, but 'smarter' operations. The science of data analytics will become an important future role and discipline in any oil and gas company.

As our challenges across the oil and gas value chain increase, so too does our need for innovation and brainpower. We will continue building on existing technology, incrementally turning our challenges into opportunities.

I expect we'll be looking back at operations 50 years from now, marvelling at how far we've come.

MR SHAUN GREGORY is Senior Vice President Sustainability and Technology, Woodside Energy Ltd. He is a member of Woodside's Executive Team and accountable for the company's efforts in advancing oil and gas technology, and stewardship of programs in health, safety, environment, quality, risk and compliance. He has worked in the oil and gas industry for more than 20 years and holds a Bachelor of Science (Hons) from the University of Western Australia in Mathematical Geophysics and a Master of Business and Technology from the University of New South Wales.



By Jonathan Law

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Technology is transforming the mining industry value chain

The Australian innovation system in mining is the envy of the world – we have a strong culture of innovation and robust collaborative innovation networks.

The mining industry is faced with significant headwinds that are exacerbated by the end of the recent resources boom and the associated decline in the prices of many commodities.

A key driver for reducing costs has been the focus on economies of scale that have stretched the boundaries of engineering and driven the development of large disseminated ore bodies.

We have now reached a point where technology-driven productivity increases are no longer sufficient to offset declining grades and their impact on profitability. The challenges are indeed significant but there are three important 'aces up the sleeve'.

First, the mining industry, and especially the Australian industry, has an enviable (but poorly understood) track record in innovation. Our mining equipment and technology services (METS) sector already employs more Australians than the mining industry itself and Australian companies export technological innovation and world leading leaders around the world.

Second, the rate of technological change is increasing in all industries and pushing the boundaries on every form of traditional business. The mining industry will be no exception – we are poised to see innovation across the entire value change that will leverage technologies from other industries and transform the way we mine and even challenge the fundamental principles of value delivery.

Third, the Australian innovation system in mining is the envy of the world – we have a strong culture of innovation and robust collaborative innovation networks. This positions us well for future challenges in the industry. Innovation in mining can be a strong foundation for the future national economy.

The mining industry is very competitive – the cost curve is a great leveller as costs fall and marginal producers are squeezed. The same is true at a national level – industry is free to choose the best development opportunities in the global market place. At the same time, nations have the ability to maximise the opportunities in their own mineral industries.

Of course mining opportunities and METS opportunities go hand in hand – mining provides a strong economic foundation to build an innovation economy beyond mining as an international exporter of mining technologies and services.

Innovation record

I am often told that the mining industry is not innovative! However, we only have to look at the decline in produced grade in many commodities over the past 50 years to see the power of innovation at work.

The industry's ability to deal with declining grade and increasing ore complexity is ample testimony to the success of innovation. Many technologies have made this possible but a few outstanding examples include:

- Bulk mining equipment;
- 'Carbon in pulp' process technology in the gold industry;
- Solvent extraction and electro-winning (SXEW) in the copper industry;
- Froth flotation for low-grade sulphide processing; and, of course,
- Heap leaching and bio-processing in the gold and base metal industries.

Opportunities

From a national perspective, there are four key areas that are essential for a healthy mining industry in Australia. Through the Mineral Resources National Research Flagship, CSIRO and its industry and

academic partners are collaborating on a suite of technologies to ensure Australia's is well positioned in four critical areas.

1 National pipeline of projects

The national resource endowment is fixed but our knowledge of this endowment and our ability to take advantage of our resource endowment is not. This pipeline of projects attracts investment and sustains the mining culture and infrastructure so essential in mining nations. Key aspects are exploration and process options:

EXPLORATION

With almost 80 per cent of our landscape buried under barren cover, technology to explore effectively 'through cover' is essential to Australia's mining future. The National UNCOVER initiative (<http://www.science.org.au/publications/searching-deep-earth-vision-exploration-geoscience-australia>) and Deep Exploration Technologies CRC (<http://detcrc.com.au/>) are at the forefront of these developments and provide a national focus to exploration research. This partnership with research groups, Geoscience Australia, state and territory surveys and industry is focused on delivering a viable pipeline of development opportunities to replace depleting resources.

PROCESS OPTIONS

In addition to exploration, many existing orebodies remain undeveloped due to mining or processing challenges. New technologies have the ability to bring these deposits to the market place. For example, two-thirds of Australia's nickel resources are hosted in low-grade oxide deposits that have proved elusive as successful development opportunities. New technologies are currently being developed to provide lower capital and operating

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cost options to enable their successful development in the future. Similarly, new green chemicals to allow extraction of gold for refractory orebodies or environmentally sensitive areas have already been developed and are undergoing industry trials.

2 Cost-competitive Australian production

Cost-competitive production is essential for any company but also aggregates at a national level to underpin the ability of a country to compete for new investment. Australian innovation touches every facet of the productivity of the mining industry – the operational effectiveness of unit processes continue to grow and this provides immediate productivity improvements and large cost savings given the volume involved. Improved recoveries, lower consumables, lower maintenance costs, improved mixing and reduced wear are all improvements delivered by Australian innovation.

3 Leadership in environmental performance

Mining is by definition an extractive industry. But in order to be viable, it must meet society's changing expectations on safety and the environment in order to continue to operate. This 'social licence to operate' is exactly that – if we fail, we cannot continue as a successful mining nation. Australia is leading the development of technologies to purify mine waters (through the 'virtual curtain'), plan long-term mine closure outcomes, improve open-pit design and implement better slope management for increased safety and productivity.

4 Resources embedded in national society

As with all industries, mining does not operate in a vacuum and there are important flow-on effects into other dimensions of the national economy. Production that is not valued by the community cannot be sustained in the longer term.

Together with the University of Queensland Sustainable Mining Institute, the Mineral Resource Flagship is pushing the boundaries of our understanding of community attitudes and the impact of mining on communities.

This interdependency is being reinforced by the advent of social media, which allows people to connect together

and to share information in ways which are not necessarily mediated by experts, those in government and those in position of power – many social media channels now have larger 'populations' than nations and they are strongly networked.

Innovation future

All of these innovation opportunities are exciting in their own right but there are some critical common threads that will integrate and transform the value across the industry value chain.

SENSORS AND RAPID RESOURCE CHARACTERISATION

Resource definition, mining and processing tends to be a slow business because there is a lag between drilling and receipt of analytical and other data. Through the rapid progress in geometallurgy that links orebody geology to process performance, the opportunity to change how we define and manage resources is compelling.

These new sensors will make mining a near real-time game and deliver information on grade, physical properties and process performance from downhole tools through to sorting of ore/waste streams. CSIRO's prototype copper mineral analyser and particle size analyser are examples of this generation of sensors that will offer the potential to sort ore streams in real time.

Through the CRC for Optimising Resource Extraction and its partners a new approach to resource management is being developed (<http://www.crcore.org.au/>) to deliver the tools and methodology to unlock this value.

CLOUD DATA AND AUTOMATED MACHINE LEARNING

A world of information is not necessarily a world of innovation and this is a fundamental challenge with sensor technologies. However, once again the mining industry is poised to benefit from rapid advances in data management and exchange and the science of extracting valuable insights.

This information is incredibly useful and cloud technologies now provide an integrated and instantly accessible data network that provides for sharing of resources to achieve coherence and

economies of scale. It also allows us to use data at a scale and for purposes that have been impossible without today's advanced computing systems and interpretative algorithms.

THE INTERNET OF THINGS

Impressive as these developments are, many still provide single point solutions – they are important pieces of the puzzle but not the end game! Mining is a physical business and so decisions in mining operations mean nothing if they cannot be implemented.

The 'internet of things' is now commonplace in industries like manufacturing where the real and physical worlds collide in a seamless delivery mechanism. In this world, equipment and people (including their health and state of readiness) is immediately transparent. This is the enabling architecture that will implement actions in the real world to drive mechanised mining operations that are progressively more autonomous.

Curse of averages

So where will this leave innovation in the mining industry?

With the ability to manage variability provided by technologies largely developed outside of mining, the industry will no longer be shackled by the 'curse of averages'.

The mine of the future will embrace variability to open up new mining technologies and new business models that are built on near real-time data, rapid decision-making and decision implementation through smart machines – the change will be extreme and Australian innovators are at the forefront of these new technologies.

DR JONATHAN LAW is a graduate of the University of the Witwatersrand. He is a geologist by training and has worked across the value chain of the mineral resources industry and in many countries around the world. A major focus of his working career has been managing the interface between research and practical applications in industry. He currently leads CSIRO's mineral exploration, mining, processing and sustainability research program as Director of the Australian Minerals Down Under National Research Flagship. The Flagship brings together CSIRO research with global partners in academia, government and industry to tackle short and longer-term challenges to the sustainability of the Australian minerals industry.

By Peter Thomas and Tim Graham

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Technology is changing the face of mining

Companies are now innovating in areas previously thought to be in the realm of science fiction, but selecting ideas with a realistic chance of implementation requires a strict process.

Figure 1 The four 'gateways' an idea must successfully navigate before it can be implemented.



Mining has traditionally been slower in adopting new technologies than many other industries – for example, the dump truck in use today is not significantly different to models produced over a century ago.

However, in the past few years, there has been extreme pressure on margins in the mining of various minerals, and the quest to address this reality has been motivated by the following key drivers:

- Reduce operating and capital costs;
- Increase productivity;
- Improve product quality; and
- Improve safety.

Companies are now innovating into areas previously thought to be in the realm of science fiction.

Autonomous trucks are a case in point. GPS and advanced communication technology has allowed autonomous vehicles to move from concept to reality quickly. The results are a paradigm shift in performance.

Where conventional dump trucks require an average of 4.5 drivers per truck each year for a double shift/double swing operation, a fleet of autonomous trucks has significantly improved availability, utilisation of availability, reduced maintenance costs, lower operating costs and do not require drivers.

Ideas selection

Selecting ideas that have a realistic chance of implementation requires adhering to a strict process. Failure to keep to the process may allow pet projects and 'wacko' ideas to creep through to implementation.

There are four 'gateways' that any idea must successfully navigate before it can be implemented.

1 Idea generation

Will the idea benefit the company? What will the impacts be on safety, production, quality and cost?

2 Assessment

What are the opportunities for the idea in the company? Who are the stakeholders? Are there any show-stoppers?

3 Development

Does the idea pass a proof-of-concept test? Has the idea been successfully implemented elsewhere, or is a prototype needed, and will that stand up to scrutiny?

4 Delivery

Implementation of the idea. Monitoring, feedback and lessons learnt are key elements of this stage.

A look at any innovative company that has failed to follow this process will show that unviable projects have been implemented and then discarded at huge expense.

Important ideas

Fortescue Metals Group (FMG) has been focused on innovation from its inception 10 years ago.

The adoption of surface mining as a mainstream process allowed FMG to selectively mine pits of variable grade successfully. This innovation allowed FMG to avoid the dilution between ore and waste associated with conventional drill and blast techniques, and therefore mine profitably in marginal areas.

More recently, FMG has been focusing on four key areas:

■ Advanced beneficiation in wet plants

The vision is to extract every last gram of high-grade iron from the upstream processes before the waste product goes

to tailings. Magnetic separation of fines is a perfect example of a technology that satisfies all the innovation drivers.

■ Advanced conveying techniques

In the same way that the dump truck has not changed dramatically for more than a century, neither has the humble conveyor. This technology has served the mining industry exceedingly well, however in term of ease of implementation

► More on page 14

Mr Peter Thomas is Director of Shared Services at Fortescue Metals Group and oversees core support functions. He joined Fortescue in 2005 as Chief Financial Officer for The Pilbara Infrastructure Pty Ltd and has had several leadership roles including General Manager Rail in 2008, General Manager 55mtpa Expansion in 2009, and Project Director T155: Port/Rail Expansion in 2010-2013. Mr Thomas has worked in mining, investment banking, management consulting, risk management and healthcare, with senior merger and acquisition roles at Novartis in Switzerland and Lehman Brothers in New York. Mr Thomas has an MBA from Harvard Business School and a BEc and BSc from Macquarie University.

Mr Tim Graham is a Project Manager with Fortescue Metals Group and is currently focused on developing Innovation and Technology within the company. He joined Fortescue in 2009. Prior to working at Fortescue, Mr Graham worked within project controls and site services with AMEC. He was previously with Rio Tinto within its gold and nickel mining operations, and was General Manager of Tetra Pak Southern Africa. He later became a director and major shareholder a junior gold mine in Zimbabwe. He is a UK Chartered Engineer and has a Mechanical Engineering degree from the University of Cape Town and an MBA from the University of Bath.



By Chris Moran
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Reducing the mining footprint: good citizenship in resources development

In many operating environments, mining companies have to go beyond legal compliance to keep their right to operate and satisfy shareholders their investment is secure.

In any industry, periods of transition offer opportunities to enact step-change solutions to problems that can make a fundamental difference to the way a sector operates.

The mining industry is in such a period of transition. As the time of huge investment comes to a close and the operating phase takes off, we are already seeing key commodity prices affecting the way we approach the industry.

It is also apparent that mining is becoming more difficult and more costly. At the time that we are in a period of possibly sustained exceptional demand, world-class ore body discoveries are rare; grades for most metals are declining and operating environments – physical, regulatory and social-political – are becoming more difficult.

The strong negative response from mining companies to threats to the operating conditions in Australia are indications that the companies know that operating margins are becoming increasingly squeezed, thereby threatening the medium-term attractiveness of the industry for investors.

In many operating environments, mining companies have to go beyond legal compliance to secure their right to operate.

It is clear that shareholders are expressing their view that only meeting local regulatory requirements is insufficient to secure their investment. This is apparent because mining companies are changing behaviour and implementing policies and practices to

demonstrate that they are doing so.

In the current minerals industry context, productivity concerns are dominant within operations. There is also clear awareness within the sector that social and environmental constraints to resources projects are dominant in terms of new developments – and in many settings globally. This is especially true during times where economic and social constraints draw focus, so it is important that organisations such as the Sustainable Minerals Institute maintain the significance of issues that might otherwise be delegated to the future.

Our mission is to responsively apply our creativity and human capital

to provide knowledge-based solutions to the productivity, community and environmental challenges of the resources sector, without compromising safety.

With our researchers well-engaged with a range of industry partners and other stakeholders, the Institute is in a unique position to 'see' what is next.

I think the future will be mining and minerals operations that are

- Automated and partly autonomous;
- Safe; and
- Employ multi-site control across groups of unit operations and possibly eventually whole operations.

Such operations will have evident human

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SUSTAINABLE MINERALS INSTITUTE

The Sustainable Minerals Institute (SMI) at the University of Queensland was established in 2001 with the aim of becoming a highly engaged, industry-focused, applied research institute. SMI's activities span research and research training, postgraduate education and consulting. Today, SMI comprises seven research centres. Each centre works in developing and applying the principles of sustainable development in much of the industry's needs:

- Julius Kruttschnitt Mineral Research Centre (JKMRC) – mineral processing;
- WH Bryan Mining and Geology Research Centre (BRC) – mining and geology;
- Centre for Mined Land Rehabilitation (CMLR) – environment;
- Minerals Industry Safety and Health Centre (MISHC) – risk, safety and health;
- Centre for Social Responsibility in Mining (CSRMI) – social responsibility and community relations;
- Centre for Water in the Minerals Industry (CWIMI) – water and energy innovation; and
- Centre for Coal Seam Gas (CCSG) – unconventional gas sector.

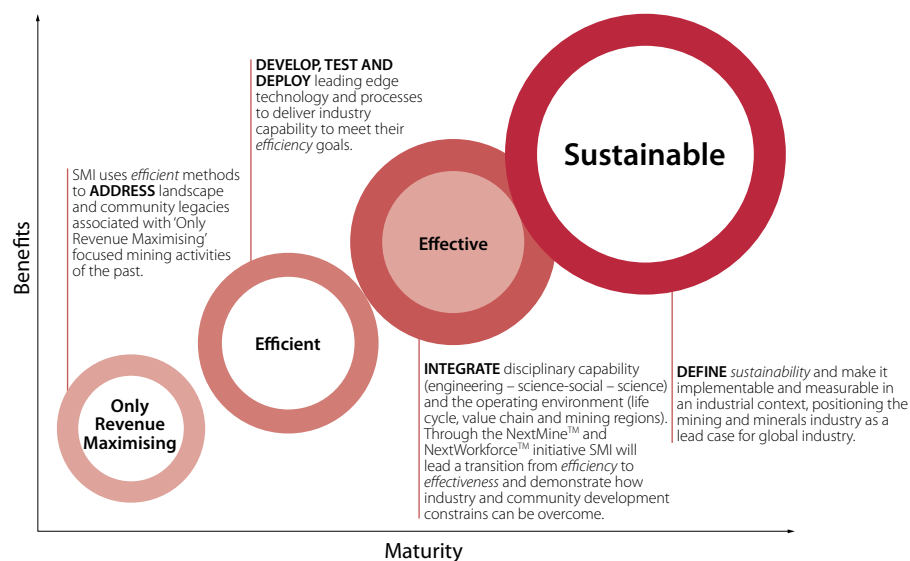
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Figure 1 A maturity journey framework of sustainability.



and social capital growth and transparent, accounted, environmental value-adding.

The operations and companies will be welcomed by local and distant communities on the basis that they have established acceptable and trusted processes for sharing value effectively.

Shareholders will see and receive greater value as a result of decision-making that realises this sort of operation, rather than focusing on short-term decision making for short-range share price volatility gains.

The industry will need to go through a number of transitions to achieve these ends. Such transitions will need to occur in technology, processes and capabilities. A number of the headline transitions will be in the areas of:

- Analysis and operational use of large

data sets derived from instrumentation and monitoring over a range of spatial and temporal scales;

- Infrastructure investment structures better meeting financial context;
- Local communities requiring new value propositions if the social contract focus on employment changes;
- Resource characterisation that incorporates a broader view of valuable body knowledge and total resource management beyond grade; and
- Safety and health changes to adapt to next technology and processing approaches.

A framework is needed that will support this transition. The figure above describes a maturity journey framework of sustainability to lift thinking out of

this 'local maximum' of efficiency.

At the least mature level focus is solely on short-term revenue maximisation, next is efficiency, with the third stage being effectiveness.

Effective systems exploit the synergies that become apparent by linking, coupling and connecting and by carefully matching systems representation and complexity to the questions, problems and opportunities under scrutiny. By increasing involvement of disciplinary perspectives across the value chain, life cycle, regions and information domains (for example, companies and governments) this increases effectiveness.

Ultimately an organisation can be determined as operating sustainably when the connectivity and appropriate systemic matching of questions and answers is embedded into business decision-making at all levels, including cross-company, cross-sector and regional synergies.

If the mining industry is to be able to play its fundamental and necessary role in facilitating the development of more than a billion people in the world:

- Old negative legacies must be repaired;
- Operations must be as efficient in terms of resources and people as possible;
- Linkages and connections between disciplines must be maximised to capitalise on synergies; and
- Operating sustainably must become integrated into business strategic and operational decision-making.

If mining companies can find ways to operate sustainably then the critical link between mineral and energy demand and supply can be made and we can increase confidence that future communities can enjoy a quality of life that we have come to expect.

◀ From page 12

and energy efficiency very little has improved. New 'wheel conveyor' systems, where the conveyor belt has moving axles and wheels, use less than half the energy that traditional idler-based systems use. Maintenance costs are also dramatically reduced because the wheel performance and condition monitoring can be carried out at a fixed point, rather than replacing idlers spread over significant distances.

- **Advanced ore-drying techniques**
Since companies are paid by their customers for delivering dry metric

tonnes, every gram of water extracted results in increased product value.

- **Lowering rail cycle times**

Using every minute of available time in the rail network system is vital for overall value chain performance.

The implementation of a new wave of innovations into the Australian mining industry will allow us to remain competitive in the global arena, as well as improve safety and add value to shareholders.

It is important that process is followed so that only the best ideas reach execution.

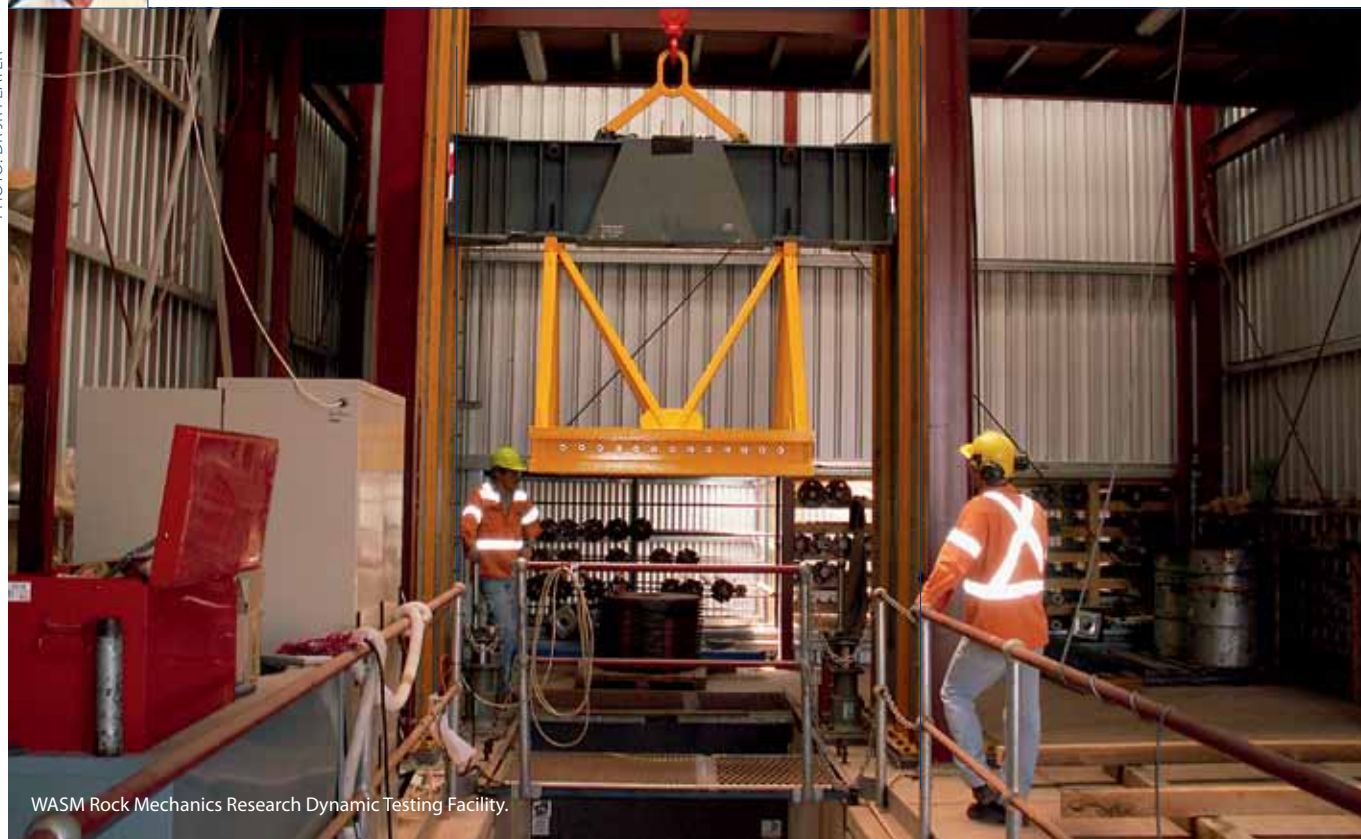
PROFESSOR CHRIS MORAN is the Director of the Sustainable Minerals Institute at the UQ. With a degree in agriculture and a PhD in soil science and digital image processing, he worked as a natural resource scientist doing spatial science at CSIRO for 16 years and has more than 20 years' of experience in landscape and water research. He has earned significant government, industry and competitive grant funds, published more than 80 papers and delivered a range of projects to government and industry. He was founding Director of the Centre for Water in the Minerals Industry from 2004, before taking on the role of SMI Director in 2008.



By Odwyn Jones

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PHOTO: DR JR PLAYER



WASM Rock Mechanics Research Dynamic Testing Facility.

Educating mining professionals faces key challenges

Universities must ensure that mining-related schools and departments have well-balanced teams of academics which include a critical mass of academics with relevant industry experience.

We are in the throes of a scientific and technological revolution which is rapidly changing the 'world of work' and the way in which we live our lives.

For example, the impact of high-speed broadband technology, along with the implementation of smart sensors and machine-to-machine communication, is leading us into a world where automation and robotics is increasingly commonplace.

If universities are to continue to produce job-ready mining professionals, academe and mining industry stakeholders must cooperate to ensure that:

- Course content and delivery relate to the immediate and future needs of industry;
- Course curricula incorporate structured 'work-integrated

learning' components; and

- Attention is paid to the increasingly global nature of industry.

Course content and delivery

University mining-related undergraduate programs should not only have academic and experiential rigour but also embody inter-disciplinary elements. For example, applied geologists, mining engineers and metallurgists could, in their senior undergraduate years, work together on group projects which simulate the interaction between these disciplines in the real world of planning, developing and managing mines.

In achieving this, the critically important teaching roles of professors, lecturers and tutors must be recognised and valued. Universities must ensure that

mining-related schools and departments have well-balanced teams of academics which include a critical mass of academics with relevant industry experience.

In this era of 'world rankings', where university performance is primarily based on research publications and citations, universities often overemphasise the requirement for teaching staff to have doctoral level qualifications. This is to the detriment of individuals with sound bachelor degrees and highly relevant industry experience. Consequently, the challenge is to find mechanisms to attract and admit appropriately experienced industry personnel into academe.

A joint university/industry approach could assist. For example, appropriately qualified and experienced industry professionals could be seconded to

a university for one or two years.

Alternatively, executives approaching the end of their careers might find it attractive to impart some of their extensive knowledge and industry expertise to undergraduate and/or postgraduate students and be invigorated by this experience.

Ensuring that course content is relevant to current and developing industry practices requires regular program reviews. The need for this is emphasised by the pace of technological change, as demonstrated by Andrew Harding, Rio Tinto's Iron Ore CEO for China, Korea and Japan in his address at an event organised by the WA Centre for Engineering Leadership and Management in August 2014.

He said the company's fleet of driverless trucks in the Pilbara had "to date, moved some 200 million tonnes of material and the company will shortly have about 65 of these autonomous trucks, with each responding to GPS directions and linked to ground station beacons to deliver loads 24 hours a day. These trucks are controlled by teams based at an operations centre in Perth, some 1500 kilometres from the Pilbara". He estimated that "the autonomous fleet alone is expected to improve the company's productivity by some 14 per cent".

Other ongoing Rio Tinto developments

referred to by Mr Harding include the trialling of autonomous production drill rigs; the introduction of the world's first automated long-distance, heavy-haul rail network in 2015; and the use of airborne VK 1 gradiometer for detecting otherwise hidden ore bodies.

Similarly, BHP Billiton is using an Integrated Archive Software Platform for processing extreme data volumes to standardise processes across its global operations to enable performance comparisons to be made. This has resulted in significant savings in such areas as maintenance scheduling and equipment purchases.

These are but a snippet of the technological developments being trialled or in the offing.

Others include the development of flexible coil-tube exploration drilling, the use of sensors to monitor soundwaves in grinding mills to assess their efficiency, and the monitoring of up to 400 data points in the large driverless trucks to continuously record information on fuel efficiency, tyre pressures, strut stresses, and so on.

Work-integrated learning

'Experiential learning' is the most effective learning system. Increasingly, undergraduate courses are being

restructured to include substantial modules of community and/or workplace experience. Students at Monash University can pursue these types of programs in a range of fields, such as medicine, nursing, health science, engineering, education, law and the arts. These programs are available across a variety of disciplines at many Australian universities, including La Trobe, Newcastle and Flinders universities.

Work-integrated-learning programs benefit students, employers and academics by facilitating more effective linkages between universities and industry, while giving students the enriching experience of relating their academic studies to workplace challenges and practices.

Students should be able to access a structured program of supervised industrial experience which helps integrate theory and practice through site visits (as part of the lecture series) and longer periods of organised industrial experience. However, it is unfortunately often left to the student to arrange his/her vacation employment directly with prospective employers.

Over the past decade the high number of overseas students attending our universities has resulted in students experiencing difficulty in finding industry placements, to the extent that some students are unable to meet the minimum mandatory requirement of 12 weeks industrial experience during their four-year undergraduate engineering courses. More effort is required in exploring how to secure suitable industry placements for international students in their countries of origin.

There is also a growing body of anecdotal evidence indicating that many international students are ill-equipped to undertake their university studies, mainly due to inadequate proficiency in the English language. If true, poor English language competency must adversely influence the overall standard of tuition and is an issue worthy of serious investigation.

If proved to be the case, entry qualifications for international students need to be more rigorously managed. However, as Peter van Onselen stated recently (*Weekend Australian*, 16-17 August 2014), "tackling this issue is a delicate one because the viability of many degrees

PHOTO: CURTIN UNIVERSITY



Students working in the Curtin University WA School of Mines Geomechanics Teaching Laboratory in Kalgoorlie.

WHAT IS FEMP?

The Federation of European Mineral Programs (FEMP) was established in late 1999 to ensure the continuation and survival of mining and minerals engineering education in Europe. It is responsible for coordinating the cooperation of 35 sponsoring companies, managing its finances and maintaining contact with some 700 alumni. The current scheme, which commenced in 2014, involves five European mining schools, offering a two-year (120 credit point) MSc course in the three disciplines of mining engineering, minerals engineering and geotechnical/environmental engineering. Participants study together at three universities in different European countries for three semesters and complete a one-semester thesis at one of the three Partner Universities.

depends on strong international numbers. After all they bring in more than \$15 billion annually for our university sector”.

The fundamental challenge of finding suitable industry placements could be alleviated by strengthening some existing career pathways and/or initiating new ones, particularly for domestic students. These could include enhancing the flow of students with appropriate TAFE qualifications and past industrial experience into undergraduate Associate and/or Bachelor degree courses and increasing industry-sponsored internships and/or cadetships for direct entrants from TAFE colleges and senior high schools.

Internships could involve a mining company sponsoring selected students for four years of industry employment and part-time study programs leading to Associate Degrees. Such a scheme for full-time BEng students could guarantee them vacation employment and also possibly provide them an annual scholarship to help meet full-time study and living costs.

Cadetships for selected students from senior high schools could comprise two years of full-time employment with their host mining companies while completing their first year of a BEng degree part-time or online and thereafter completing their course full-time with the benefit of an annual scholarship.

A globalised industry

Universities have to face the challenge of preparing university graduates for an increasingly globalised industry, as well as providing continuing education courses for a global audience.

Within the university system these challenges can be best achieved through establishing international university partnerships which facilitate interchange of both university staff and students. While acknowledging that many Australian university mining schools and departments are engaged in such partnerships, the FEMP initiative provides a model which could be replicated in our South-East Asia/Pacific region.

Our challenge is to expand international linkages and explore the establishment of formalised partnerships similar to FEMP between Australian mining schools and selected partner institutions in countries such as India, Indonesia, Malaysia, the Philippines, South Africa and Chile.

As FEMP has a sponsoring network of 35 companies in 12 countries over three continents, many of whom have

substantial investment portfolios in this region, it shouldn't be too difficult to secure equivalent support for similar schemes in the southern hemisphere.

Discussion on the future of higher education must be underpinned by three fundamental objectives:

- Equal opportunity and affordability for all suitably qualified Australian aspirants;
- Delivery of highest quality educational experience; and
- A qualification with global recognition and relevance.

Within the mining context these goals can only be achieved through close cooperation and collaboration between academe and industry stakeholders.

EMERITUS PROFESSOR IFAN ODWYN JONES AO, served as the Principal of the WA School of Mines and Dean of Mining and Mineral Technology at Curtin University of Technology (1976–91). His ongoing commitment to promoting improvements for the WA mining industry led him to the position of the Chair of the Minerals Research Advisory Committee of the Minerals and Energy Research Institute of Western Australia from 1998 to 2013. Professor Jones has advocated tirelessly for strong mining education programs and engagement of students with the mining industry. The Odwyn Jones Research Awards Program for Honours students seeks to recognise his contribution.

UWA-DESIGNED ANCHOR GOES DUTCH

An innovative offshore anchor designed by researchers at The University of Western Australia has already been snapped up by Dutch anchor specialists Vryhof Anchors.

The Dynamically Embedded Plate Anchor (DEPLA) reduces installation time, costs and materials and is aimed at mobile drilling units and floating production systems in deep and ultra-deep water.

Associate Professor Conleth O'Loughlin, from UWA's Centre for Offshore Foundation Systems (COFS), who has been researching dynamically installed anchors for the past 10 years, said the anchor was a hybrid system able to sustain significant vertical load and required no external energy source or mechanical operation for installation.

"The anchor resembles a dart, and is installed using gravity, similar to other dynamically installed anchors such as the torpedo pile," he said.

"However the main part of the 'dart', which we call the follower, is removed after the anchor is embedded in the seabed and re-used for the next installation. This leaves the anchor flukes in the seabed, which then become the plate anchor."

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Please address to editor@atse.org.au

By Vanessa Guthrie
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Technology is reshaping the nuclear industry, so time for minds to follow

Perhaps the public is neither aware of nor understands radioactivity and how it provides both energy and medical solutions in a safe, efficient and reliable way.

Nuclear technology has been a part of our everyday life for more than 60 years. Born early in the 20th century out of the defence and security industry, nuclear technologies today represent one of the most effective and valuable technological developments of this generation.

Specifically, nuclear science and technology has benefited society by providing the most efficient method of generating power with low-carbon emissions,

as well as applications of radioisotopes and technologies used in the diagnosis and treatment of medical conditions.

Nuclear technology has clearly advanced in the area of power generation since the original power plant was commissioned in the USSR in 1954.

While some of these original first- and second-generation power stations are still safely and effectively in operation, the latest generation of power stations have further improved the safety, efficiency

and reliability of power reactors.

Reactors classified as third-generation advanced reactors were initially commissioned in Japan in 1996. Compared to the earlier designs, these reactors have a higher availability and efficiency, longer operating life (typically 60 years), and a simpler, more rugged design, which makes them safer and easier to operate.

Of specific interest to the public, improvements have been made in the development of passive safety and control measures that significantly reduce the possibility of core melt accidents. New generation reactors are now designed to function without active controls or operator intervention during both routine and abnormal conditions, and don't rely upon other engineered components to remain safe and reliable.

Many of the technological improvements in nuclear power have been developed as a result of significant incidents or failures in reactor performance. Over the more than 60 years of operation of the nuclear power sector globally, there have been just three key events that have shaped the industry.

In their own way, each of the Three Mile Island, Chernobyl and Fukushima incidents have caused technological advancement in reactor safety, operation, engineering, design and maintenance practices. Improvements have been, and continue to be, applied to all generations of nuclear reactors, including the older technology and design that will be phased out over time to ensure the highest safety standards are met.

Further, as older reactors are coming to the end of their useful life, they are being replaced by upgraded designs that result in a step-change improvement in operational safety and efficiency.

Generally, the capacity of nuclear reactors has increased from the 1950s

ANSTO LEADS WORLD IN SILICON IRRADIATION



PHOTO: GMEUROPE

Silicon from ANSTO is used throughout the world in electronic components of hybrid cars.

Irradiated silicon from ANSTO is used throughout the world in electronic components of hybrid cars, fast trains, renewable energy systems such as solar and wind farms, and in energy transportation to cut down energy losses and to increase device reliability and efficiency.

Australia is now recognised as the country which irradiates the most high quality silicon in the world – another example of nuclear science delivering high-end manufacturing solutions.

ANSTO is experiencing unprecedented demand for silicon irradiation services from Asian and European electronics companies, and this strong performance is expected to continue.

In 2013, ANSTO's silicon production increased by 49 per cent (from 23 to 34.5 tonnes) and world market share grew from 20 per cent to 29 per cent, making Australia the world's primary producer. This is expected to increase further in 2014, and forecast to be more than 50 tonnes in total.

"ANSTO's expertise in applied nuclear science is world-class, and is increasingly becoming world scale," said the Group Executive for ANSTO's Nuclear Business, Shaun Jenkinson.

"The irradiation of silicon is an important business for ANSTO, and allows us to make a significant contribution to the high technology electronics industry.

"And when you consider our \$168 million plans to help provide the world with nuclear medicine, which are now well underway, you can see a theme of Australia developing high-end manufacturing capabilities based through our nuclear research infrastructure.

There are few high-end manufacturing businesses where Australia can claim to be number one in the world, but thanks to the Australian Nuclear Science and Technology Organisation (ANSTO), silicon irradiation is one of them.

Irradiating silicon, technically known as a process called Neutron Transmutation Doping (NTD), changes electronic properties of silicon by introducing phosphorus and making it more conductive of electricity.

from 60MWe (Megawatt electrical) to more than 1600MWe per unit.

Despite the economies of scale of larger, modern reactors, the initial high capital cost of such a reactor can remain a hurdle for investment and generally requires a large power demand to make them effective. This has generated a revival of interest in small (less than 300MWe) and medium-sized (up to 700MWe) simple reactor units that do not have the same initial capital burden as larger reactors and are suited to more flexible and smaller demand purposes.

As a result of this improved nuclear technology, small and medium reactors (SMRs) can now be produced as independent reactor modules and located close to the end power user, thereby significantly reducing on-site construction and infrastructure costs. This cost efficiency means that nuclear power can provide access to electricity to millions of people who currently live in energy poverty in the emerging and developing economies, such as India and Africa.

In 2010 the European Commission launched the European Sustainable Nuclear Industrial Initiative (ESNII) to help develop a new generation of nuclear energy reactors designed to respond to Europe's growing energy needs, while meeting the stringent targets to reduce greenhouse gas emissions. The initiative focused on the further development of Fast Neutron Reactor (FNR) technology which has the potential to multiply energy output by 50 to 100 times, and improving the management of high-level radioactive waste.

Like SMRs, this technological advancement will further provide an opportunity to bring increased access to electricity globally.

Development of nuclear technology has not been limited to power generation. Medical diagnostics and treatment have also benefited from an improved understanding of nuclear science and improvements in technology. In particular, radioisotopes have been used in medicine for more than 30 years in a range of medical uses (radiopharmaceuticals) including the diagnosis of organ functions and to detect and treat cancers.

For example, one of the main duties

of the current Open Pool Australian Lightwater (OPAL) reactor at the Australian Nuclear Science and Technology Organisation (ANSTO) operation near Sydney, which has operated as a research reactor since 1958, is to create a range of radiopharmaceuticals for medical applications. In particular, ANSTO produces Technetium-99m, which is used in 80 per cent of nuclear medicine procedures worldwide.

Without access to the reactor in Australia, thousands of people in Australia would have been denied access to life saving medical treatments using nuclear technologies.

So with such a positive track record of delivering scientific and technological advancement to society, why does nuclear industry suffer from such a poor public perception? One plausible

reason is that the public is neither aware of nor understands radioactivity – and how it provides both energy and medical solutions in a safe, efficient and reliable way.

Moreover, nuclear science is often shrouded in a mysterious language that make it hard for the public to understand and leaves the way open for others to create a sense of fear around that which is poorly explained and understood.

Overcoming fear, biases and prejudices is not easy, but we do nevertheless see progress. Politicians previously opposed to nuclear energy are steadily updating their views as they come to recognise the benefits that nuclear power and medicines provide. More environmentalists are also supporting nuclear power in our carbon-constrained world and many communities where nuclear industries exist are increasing acceptance. Building and maintaining community trust is not easy but is possible with honest, respectful and transparent communication.

The global nuclear power sector is now more than 60 years old and technology and understanding of the nuclear power cycle has improved



Nuclear energy has diverse medical applications

greatly over that journey. Many lives have also been saved by the application of nuclear medicine and diagnostics.

Against this background, nuclear power generation deserves to take its place as an efficient and safe source of power that contributes to meeting global energy demand in a sustainable way, just as nuclear medicine is becoming more and more accepted.

It's time for science and technology to shift public opinion to one that understands the value nuclear science adds to our lives.

DR VANESSA GUTHRIE is Managing Director/CEO of Toro Energy Ltd and has qualifications in geology, environment, law and business management, and an extensive background in the mining and resources sector. She is one of Western Australia's foremost resources sector executives, with more than 25 years' experience in a range of leadership roles in mining operations and corporate affairs including with Woodside Energy, WMC Ltd and Alcoa in WA, RGC Ltd and Pasminco Ltd in Tasmania. She is a non-executive Director at the WA Water Corporation and a member of Minerals Council of Australia (MCA) Board, as well as being on a number of not-for-profit boards.

Align science to the national interest, says Chubb

Australia's Chief Scientist, Professor Ian Chubb AO, says science is infrastructure and is critical to our future.

Speaking at the September release at Parliament House, Canberra, of his recommendations for a strategic approach to science and its related fields, Professor Chubb said *Science, Technology, Engineering and Mathematics: Australia's Future* outlined what Australia had to do to build a stronger, more competitive Australia nation.

"We must align our scientific effort to the national interest; focus on areas of particular importance or need; and do it on a scale that will make a difference to Australia and a changing world," Professor Chubb said.

The document – subtitled 'An Agenda for Change' – focuses on:

- Building competitiveness;
- Supporting high-quality education and training;
- Maximising research potential; and
- Strengthening international engagement.

"We are the only OECD country without a science or technology strategy. Other countries have realised that such an approach is essential to remaining competitive in a world reliant on science and science-trained people." – PROFESSOR IAN CHUBB, CHIEF SCIENTIST FOR AUSTRALIA

"I have outlined how to develop better capacity and capability through strategic investment, good planning and long-term commitment," he said.

"We are the only OECD country without a science or technology strategy. Other countries have realised that such an approach is essential to remaining competitive in a world reliant on science and science-trained people," Professor Chubb said.

"I have drawn on the views of our science community and Australian business in framing this set of recommendations. I look forward to continuing working with government in

securing a better future for Australia."

The 40-page report makes the case strongly.

"The global economy is changing. New technologies and smart companies lead. New industries and new sources of wealth are emerging. New skills are required for workers at all levels.

"Australians must decide whether we will be in the forefront of these changes or be left behind. We have a choice.

"Our competitiveness cannot be underpinned by our natural resources alone. Nor can we afford to be complacent about our place in the global race. Nations at all levels of development are now focusing on the capabilities required for building new jobs and creating wealth. In partnership with business, they are acting now to secure the skills, investment and international alliances for the future.

"At the core of almost every agenda is a focus on STEM: science, technology,

engineering and mathematics. It is the almost universal preoccupation now shaping economic plans. In other words, the economic plans are designed to support the focus on STEM, rather than limit it.

"We too need to recognise that prosperity has to be earned; just as opportunity must be embraced. Above all, we need to ensure that our needs and our capabilities are aligned: across government and across the Australian community.

"It is the knowledge that STEM will offer and the sensible application of that knowledge that are the means to the end: building a stronger Australia with a competitive economy," the report says.



Ian Chubb

"The end we aim to achieve is to build a stronger Australia with a competitive economy. We will need to facilitate growth in ways and on a scale that we have never achieved before. It is time to do what so many other countries have already done: take a long-term strategic view of STEM's pivotal role in securing a stronger Australia."

Looking forward, under the heading 'The Means to an End', the report says:

- **Australian competitiveness** – STEM underpins a differentiated and readily adaptable economy that is globally competitive and will enable all Australians to benefit from the opportunities that follow;
- **Education and training** – Australian education – formal and informal – will prepare a skilled and dynamic STEM workforce and lay the foundations for lifelong STEM literacy in the community;
- **Research** – Australian STEM research will contribute knowledge to a world that relies on a continuous flow of new ideas and their application; and
- **International engagement** – Australian STEM will position Australia as a respected, important and able partner in a changing world, for both domestic and global benefit.

Science, Technology, Engineering and Mathematics: Australia's Future is on the Chief Scientist's website www.chiefscientist.gov.au

ATSE IN ACTION

ATSE calls for a research 'Impact and Engagement'

ATSE says researchers and industry must get closer together.



The Academy has taken strong steps to more strongly link academic research to real outcomes, calling for a new way of measuring the impact of academic research to encourage collaboration in Australia.

ATSE has written to the two relevant Federal Ministers, Ian Macfarlane (industry and science) and Christopher Pyne (education), outlining its Proposal and taken the issue to news media.

The Academy is concerned that OECD data shows that Australian researchers are less engaged in collaboration with industry than their counterparts in other countries. This is of particular concern for Australia given the large proportion of our researchers in the public sector. Calls to address this problem have increasingly been heard from government and industry.

ATSE has proposed an initiative to increase collaboration in the science, technology, engineering and maths (STEM) and humanities and social sciences (HASS) areas.

ATSE notes that the current Excellence in Research Australia (ERA) initiative encourages university researchers to publish quality research in highly cited journals and rewards this behaviour by allocating approximately \$65 million per annum based on ERA outcomes.

While research excellence is desirable in its own right, the ERA is having the unintended effect, the Academy says, of discouraging university researcher engagement with business, requiring a counterbalancing measure to ensure that collaboration is appropriately recognised and rewarded.

Encouraging engagement

To encourage more engagement between universities and industry, ATSE proposes the following:

- That an 'Impact and Engagement for Australia' (IEA) metric be determined in parallel with the current ERA 2015 exercise. The data needed for the IEA is already being collected for ERA 2015, so there are no additional costs involved in determining the IEA;
- The non-philanthropic dollar amounts collected in the ERA

2015 exercise in the 'Industry and other Research Income' and 'Research Commercialisation' categories will be summed as a proxy for Impact and Engagement and used to determine the rank obtained by an institution for IEA;

- The IEA metric would be determined in 2015 in parallel to the ERA on a trial basis, and institutions would be ranked on a grading from A (top 25 per cent nationally) to D (bottom 25 per cent nationally) – no subsequent funding to institutions would be associated with the IEA rankings obtained in the trial;
- Institutions would then receive results for both ERA and IEA;

ATSE proposes a method for determining the IEA which is set out in the ATSE Proposal sent to all Fellows in August and available on the ATSE website at [Activity>>Industry and Innovation>>Reports](#).

- As the rank of IEA will be determined by comparison with the national average, both STEM and HASS fields of research will be compared to the institutional national average applying to that field – research fields with relatively lower dollar income will

not be disadvantaged against fields with higher dollar income; and

- The determination of IEA will in no way alter funding linked to the ERA 2015 exercise.

ATSE recommends that Proposal could be trialled for the ERA 2015 returns, on the understanding that there would be no funding attached to the results in the IEA category.

However, it suggests that if the exercise is judged to be informative, useful and – most importantly, – influences behaviour, then this process could be repeated in subsequent ERA iterations and have institutional funding linked to the impact rankings.

The Proposal was developed by Fellows of the Academy in consultation with experts and stakeholders in the field. Members of the ATSE Research Impact Advisory Group were Professor Peter Gray FTSE (chair), Dr John Bell FTSE, Dr Alan Finkel AO FTSE, Professor Paul Greenfield AO FTSE, Mr Peter Laver AM FTSE and Professor Tanya Monro FAA FTSE.

MIN GU DELIVERS WARK LECTURE

Professor Min Gu FAA FTSE, Centre for Micro-Photonics, Swinburne University of Technology, winner of the 2014 Ian William Wark Medal and Lecture, awarded by the Academy of Science, delivered his lecture at the Ian Wark Medal dinner in Canberra in September. As a pioneer in photonics at the nanoscale, Professor Gu has developed green nanophotonic innovations which have significant benefits including low energy consumption big data centres, early cancer detection and environmentally friendly solar cells. The dinner was hosted by the AAS President, Professor Andrew Holmes AM FRS FAA FTSE, and attended by Academy president Dr Alan Finkel AO FTSE.



Dr Alan Finkel (left), Professor Min Gu and Professor Andrew Holmes at the Ian Wark Medal Dinner.

ATSE IN ACTION

STELR now in 400 schools

The STELR program (Science and Technology Education Leveraging Relevance) has achieved a major milestone, with 400 schools in Australia, New Zealand and Asia using the system, which is designed to generate more interest from high school students in science and technology subjects.

The 400-school achievement also marks nearly five years of support for the STELR program from Orica, an Australian company with a global footprint, which has a diverse workforce of more than 14,000 people providing mining services and mining, general and industrial chemicals.

The 400th STELR school, Kurri Kurri High School, located near Cessnock in the NSW Hunter Valley, has been totally supported in the STELR program by Orica, which has contributed \$750,000 to STELR since 2009. The 400th school achievement was celebrated by STELR and Orica on 29 August.

Orica's support has helped ATSE to:

- Support the roll out to 182 secondary schools of the ATSE STELR Stage One Project in 2010;
- Supply equipment to schools;
- Provide teacher training;
- Provide support to schools while



Kurri Kurri High School students use the STELR equipment.

implementing the project;

- Contribute to the evaluation of the project by a team from Curtin University;
- Produce a 10-minute stimulus video *Global Warming – Cold Facts, Hot Science*; and
- Produce web resources such as career profiles and case studies.

The grants were subsequently used (2011–14) to provide \$3000 subsidies to schools for the purchase of STELR classroom equipment packs, as well as staffing, development, implementation and training support.

The STELR program has been embraced by 395 Australian schools, one in Singapore and four in New Zealand, where Mount Maunganui College, on the Bay of Plenty, is also totally supported by Orica.

The Academy's STELR program addresses educational and workforce issues of national importance and aims to:

- Increase the number of Australians training

for careers in technology fields;

- Increase interest in science and maths education and encourage science-trained graduates into teaching;
- Increase science and maths literacy of the population; and
- Increase interest, knowledge and engagement in environmental sustainability, which is a global and national issue.

STELR achieves this through:

- Problem-based learning using contemporary, highly relevant and multidisciplinary topics;
- Inquiry-based learning and hands-on activities and evidence-based thinking;
- Full alignment to national science and maths curricula;
- In-curriculum delivery to all students in the relevant year levels at all participating schools, building science literacy skills for all students; and
- Enhanced teaching quality by supporting teachers via training and teaching tools, mentoring and online support.

Evaluation of the program has shown that:

- Over 50 per cent of schools reported an increase in students studying science at Year 11; one school showed a 100 per cent increase in girls studying Year 11 physics;
- Boys and girls engage more with STELR modules than regular science topics;
- Teachers teaching 'out of field' are more confident teaching the STELR modules;
- Students are more aware of what is involved in engineering and technological careers and the study pathways necessary to gain access to these careers; and
- Student science literacy has increased in more than 80 per cent of schools.

TASMANIAN TEACHER TAKES ATSE AWARD

An outstanding Tasmanian science teacher has been honored for inspiring her students to further their studies in science. Ms Robyn Aitken from Kingston High School is the 2014 winner of the Australian Academy of Technological Sciences and Engineering Prize (Tasmanian Division) for Science Teaching in secondary schools. The prize is sponsored by the Faculty of Science, Engineering and Technology (SET).

"This prize acknowledges the outstanding contribution made by our State secondary science teachers and the Faculty is very pleased to contribute to the award," said SET Dean, Professor Margaret Britz.

The prize includes the opportunity for the winning teacher to bring their students onto a university campus to visit science facilities and to take part in hands-on activities.

Ms Aitken is an Advanced Skills Teacher at Kingston High School, Hobart. She has more than 25 years' experience teaching science and maths in government schools in Tasmania, including rural, city, low socio-economic and distance education. She is passionate about teaching science inquiry and sharing this through professional learning at workshops at both state and national conferences. She currently holds the voluntary role of President of the Australian Science Teachers Association (ASTA) and has previously been President of the Tasmanian Science Teachers Association (STAT).

ATSE IN ACTION

Technology and engineering are key to Australia's north

The private investment required to develop northern Australia will remain elusive without sufficient evidence and comprehensive business plan and continuing investment in science, technology and engineering-related disciplines will be essential to provide the evidence base for sustainable development.

This is a key message in the Academy's submission to the Prime Minister's Northern Australia Taskforce *Green Paper on Developing Northern Australia*, lodged in August.

This investment must cover the whole spectrum of education and training, through to the improved translation of public investment in science and technology into economic, environmental and social outcomes, ATSE said.

ATSE welcomed the start of the discussion on the multidimensional challenge of strategic development across northern Australia, noting the unique environment, biodiversity,

resources and culture of the north were a significant and valuable advantage for Australia.

"Seizing these advantages in the most beneficial way for all Australians in general and the region's population in particular – including its traditional owners – will require careful consideration and detailed, long-term planning," the submission said.

"The protection of the region's unique and delicate ecosystems is of critical importance to consider in any strategic development plan.

"The *Developing Northern Australia White Paper* process has made it clear that there is significant interest in the concept of a plan for the strategic development of northern Australia from a range of stakeholders.

"A significant benefit of this consultation process may be the development of a 'critical mass' of interested parties to drive the ideas that will underpin northern development.

"While the concept and desire for increased

levels of development in northern Australia is not new, to date there has been a lack of well-developed business plans or an overarching vision to guide this ambitious concept in a strategic, far-sighted manner.

"The current process offers Australia a unique opportunity to devise a strategic plan and vision to develop one of the largest areas of tropical and subtropical land in any advanced nation in the world."

ATSE cautioned that this could not be an ad hoc process, but one which required significantly greater levels of ambition, vision and planning from Australian governments.

The submission noted that bipartisan support would be crucial – as would be dealing with water resources, climate change and extreme weather events and identifying key sites for resource development in a holistic fashion – in building a strategic plan for Australia's north.

Fellows lead two new ACOLA projects

ACOLA has commenced two important new projects under its Securing Australia's Future Program.

'Australia's agricultural future', led by Dr Joanne Daly PSM FTSE of CSIRO, will bring ACOLA's unique interdisciplinary focus to a crowded space that is of critical importance to Australia's future.

'Sustainable urban mobility' will take a unique look at the future mobility of goods and people in Australia, and will be led by Dr Bruce Godfrey FTSE.

Dr Daly will chair the Expert Working Group, which will include Professor Bronwyn Harch FTSE, which will explore the critical challenge of optimising agricultural production while maintaining Australia's unique capacity and reputation both nationally and internationally.

The project acknowledges that agriculture is an important part of the Australian economy and an area of significant comparative advantage. Agriculture can post major successes in developing and adopting innovations and new technologies

particularly in dryland cropping, pasture-based production systems and biosecurity arrangements that protect against pest and disease incursions. The essence of our comparative advantage is our reputation as a producer of clean, green, safe, affordable, sustainable and ethical food and other agricultural products.

Dr Godfrey will chair the Expert Working Group for the second project, which will synthesise cutting-edge research on alternatives which look at optimising the transport system for lower emissions within and between innovative urban infrastructures, and will examine effective ways to counter the institutional and cultural obstacles to transformational change.

The project recognises that Australia is one of the most urbanised nations in the world, with almost

90 per cent of the population concentrated in five metropolitan areas. Projected urban expansion and the residential expectations of many Australians are raising acute questions relating to the planning and provision of social, economic and physical infrastructure, with mobility and accessibility at the centre.

Australia's capacity to transition to affordable, reliable, low-emission transport will underpin the future security of the mobility of people and goods.

This project will synthesise cutting-edge research on alternatives which look at optimising the transport system for lower emissions within and between

innovative urban infrastructures, and will examine effective ways to counter the institutional and cultural obstacles to transformational change.



Joanne Daly



Bruce Godfrey

ATSE IN ACTION

Time to take a new look at manufacturing

Australia's manufacturing is under stress – as a share of industry output, it has declined by almost 50 per cent in the past 20 years, while financial services, mining and other related business areas have grown.

Australia's competitiveness had declined significantly against OECD partners over the past decade – a situation not unique to Australia, but reflecting a global trend as the world moved from a traditional manufacturing-intensive 'Machine Age' economy to a services-intensive 'Information Age' economy.

These were key points made by Mr Bruce Grey in his in July address to a packed room in the second of ATSE's NSW Division Sydney luncheons on how Australian manufacturing can remain globally competitive.

The definition of manufacturing needed to change, he said.

"The \$30 billion experiment Australia had with the car industry is over, and let's hope we don't go down that track again."

Before 2000, manufacturing generally referred solely to the production of goods. Today, manufacturing was about ideas, products, processes and services. This post-industrial global manufacturing system represented a complex and highly integrated value chain. It included cutting-edge science and technology, innovation, skills, design, systems engineering, supply chain excellence and a wide range of intelligent services as well as energy-efficient, sustainable and low-carbon manufacturing.

Intelligent services now regarded as cutting edge, were not exempt, he said – computerised algorithms would take on tasks previously performed by people and do them better; and any job that relied on storing, accessing and – to some extent – processing information was at risk.

Logistics occupations were under threat of computerisation due to the ability of algorithms to work with big data gathered from autonomous vehicles navigating the world, enabling them to operate in exactly the same way as a human driver would. Examples of trades being challenged by automation included truck drivers, forklift drivers, taxi drivers, and drivers of mine equipment, he said. Robotics would eliminate many of the repetitive, low-skilled jobs in our economy.

He predicted a shortage of skilled employees and a surplus of unskilled workers, as industry lifted its productivity through computer systems and automation – which highlighted the need for Australia to invest in all levels of tertiary education and up-skilling of workers. Industry needed to put pressure on government policy-makers.

New manufacturing jobs in the future could be in the rapidly growing services and health sectors. Biomanufacturing, additive manufacturing and robotics would impact many Australian manufacturing businesses.

Most of the technologies behind the smart phone, internet, GPS and the touch screen were all state-funded, he noted, but they were funded not through investments targeted at

market failure but through investments that were mission-driven. Putting a man on the moon required 13 different sectors to interact, as well as large amounts of state funding in particular technologies.

Productivity driver

Manufacturing was a key driver of productivity improvement – with each job in manufacturing generating on average between two and five jobs elsewhere in the economy. Taiwan presented a good example – a country with a dearth of natural resources, a similar population to Australia but a thriving export industry in high-tech manufacturing, focusing on semiconductors and microelectronics.

As a percentage of GDP, Australia's R&D expenditure was less than the OECD average and almost half that of the leading nations, such as Israel and Sweden. Unfortunately, Australian R&D was dominated by the government and university sectors.

Australians were not good at collaboration, he said, noting OECD statistics. Australia had some of the best researchers in the world, but publicly funded researchers were disconnected from our diverse collection of manufacturing SMEs.

The CRC program needed changes, he said. It was supposed to foster collaboration and was unique to Australia, but was not working as planned.

He noted that when the Australian Manufacturing Cooperative Research Centre (AMCRC) visited more than 170 manufacturers around Australia most were unaware of the CRC program, even though it had been operating for nearly 20 years. Most manufacturers expressed interest in collaborating with the publicly funded research sector but either did not know where to start, or were too focused on their business and needed help.

Australia was spending \$10 billion on innovation support.

"We don't need to spend more. We just need to spend it more wisely. Today we don't

FACTORS THAT WILL CHANGE MANUFACTURING

- **NEW MATERIALS** – nanomaterials, nano-enabled pharmaceuticals, carbon fibre and other strong, lightweight materials;
- **PRODUCT DESIGN** – the internet of things, advanced analytics, social media and crowd innovation;
- **INFORMATION SYSTEMS** – digital manufacturing process modelling and simulation, big data and advanced analytics;
- **PRODUCTION PROCESS** – biomanufacturing, additive manufacturing (3D printing), flexible industrial robotics; and
- **BUSINESS MODELS** – mass customisation, frugal innovation, circular economy, new service models.

ATSE IN ACTION



Australia spends \$10 billion on innovation support. We don't need to spend more. We just need to spend it more wisely. – BRUCE GREY

Bruce Grey FTSE is one of Australia's leaders in manufacturing innovation, having commercialised Australian R&D in many countries including Germany. As CEO of Bishop Technologies he took his company's IP and products into ventures with world technology leaders including Thyssen Krupp, Daimler Benz and the Ford Motor Company. From 2009 until recently he was Managing Director of the Advanced Manufacturing CRC. He served as Chairman of the Federal Government's Advanced Manufacturing Action Agenda, and as a member of the Future Manufacturing Industry Innovation Council.

The great disconnect

Mr Grey posed the question: "Why do we have a disconnect between publicly funded researchers and industry?"

- Publication remains the key performance indicator for academic investigators, despite lip service paid to commercial criteria in grant processes. There were very few commercially experienced practitioners and the Australian academic research culture did not sufficiently value or understand the process of commercialisation or the transition from discovery to definition.
- Funding for product definition did not fit within the scope of the NHMRC Project Grant or the ARC Discovery Grant schemes, and only very limited funding could be accessed through the sub-optimal NHMRC Development Grant scheme.
- The inherent high risk of failure involved in the product definition stage of commercialisation was a barrier to accessing commercial investment from Australian sources. Often opportunities are identified, but commercial development abandoned due to the inability to source funding for proof-of-concept and

validation studies during the time between filing the first provisional patent and an international patent.

- There is also a major funding gap for IP protection. The NHMRC and ARC both explicitly forbid grant funds being used to cover patent costs.
- There was also the problem of researchers needing to publish and present work for career progression too early in the patenting process, resulting in commercial support for patenting costs being difficult to obtain, and patents being abandoned. For example, many SMEs and universities would not progress to national phase entry unless there was a licensing partner who would at least cover future IP costs. Without patent protection, the product development phase of commercialisation never commenced.

Australia must work smarter, innovate, collaborate and educate its workforce of tomorrow to thrive in an increasingly interconnected world, he said.

– CONTRIBUTED BY BRIAN SPIES FTSE

have mission-driven collaborative objectives because our governments are internally focused on austerity."

Compared with our competitors, Australia performed well in the uptake of technologies, he said.

"But we fail miserably and are letting ourselves down in IP applications, trademark, registrations, industrial design registrations and proportion of firms with new-to-market products. We fail miserably in generating just half of the OECD average number of patents per capita."

IP and intangible assets were a critical component of the new manufacturing. Australia was falling behind its competitors in the creation of IP and intangibles. Intangible assets formed a growing portion of corporate balance sheets in the US and Europe. China had recognised the value of IP with the number of patent applications soaring in recent years, and now surpassing the US.

We must translate research better

The issue of productivity in Australia remains a key national issue and a vital focus for the Academy.

ATSE has produced an Industry and Innovation Position statement, which was at the heart of our recent submission to the Senate Inquiry on Innovation.

The thrust of the Position Statement, and the submission, was consistent with what ATSE has been saying repeatedly for some time now: Australian industry competitiveness depends significantly on the ability to translate investment in science, research and development (R&D) into economic benefits.

"This implies boosting productivity through the uptake of new technology and technical innovations, including efficient capture of new innovations from overseas," Academy President Dr Alan Finkel AO FTSE said.

"It's no secret that productivity is a key driver of prosperity, economic growth and living standards. But productivity growth in Australia has been flat or declining for a number of years, threatening our global competitiveness.

"While Australia has a world-class research base, our translation of publicly funded research outputs into economic benefits is poor.

"ATSE's position – proclaimed at every

opportunity – is that lifting Australia's industrial and business productivity through research, innovation and collaboration must be a key priority for our competitiveness.

"Australia needs to rethink the way public money is applied to research and a renewed focus on high-technology high-value industries that drive productivity through technological innovation to produce high quality products and services," he said.

Fellows can see the Position Statement online and a print copy has been circulated with ATSE Focus.

WOMEN IN TSE

By Susan Pond
susan@pondemail.com



Women face a thicket of obstacles

Gender equality in science, technology and engineering will be a long process.

Women in science, technology and engineering in Australia face a thicket of obstacles in achieving their potential and using their skills to boost Australian innovation and productivity.

Issues magazine (June 2014) published an article which concludes that “we must tell all young girls (and boys) in Australia that they too can find alternative energy solutions, design the bridges of tomorrow,

explore the origins of the universe and develop treatments for incurable diseases”.

The Academy of Technological Sciences and Engineering (ATSE) agrees.

ATSE Fellows are celebrated for their achievements in applied sciences, technology and engineering. In 2010, the Academy recognised and took steps to achieve significant and sustainable increases in the representation of women in leadership positions and redress the

gender imbalance within its own ranks.

As the first step, the Board endorsed and published the ATSE Gender Equity Policy Statement and then set about ensuring that women were well represented on ATSE’s Board of Directors and major committees. On most occasions, all that was required to achieve this goal was to slow down the thought processes when names were being considered for positions and raise the question – which women are (also) eligible?

The percentage of women on ATSE’s Board has increased steadily from 10 per cent (1 of 10) in 2009 to 50 per cent this year, 2014.

None of the chairs of ATSE’s seven State and Territory Divisions were women in 2009, but 2014 saw the election of three female chairs. Women now chair three of the eight ATSE Forums, which focus on specific topics such as energy, water and agriculture.



Ms Kathryn Fagg, Chair,
Industry Innovation Forum.



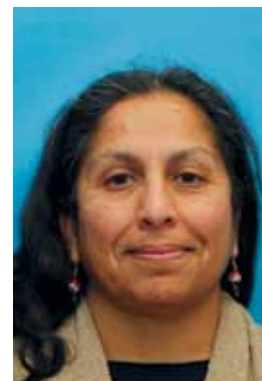
Professor Kaye Basford,
ATSE Director.



Dr Margaret Hartley,
ATSE CEO and Director.



Dr Leanna Read,
ATSE Director.



Dr Meera Verma, Chair,
South Australian Division.

SWINBURNE MOVES ON GENDER GAP

Swinburne University of Technology has launched a Gender Equality Strategic Action Plan, developed in line with the *Workplace Gender Equality Act 2012*, a law designed to promote and improve gender equality.

Swinburne’s Gender Equality Strategic Action Plan will deliver three key initiatives:

- Flexibility @ Swinburne – a program promoting flexible working arrangements;
- Swinburne Connection – a transition program for parents returning to work from parent leave; and
- ‘You the Man’ – a theatre-based program which tackles issues of bystander engagement and violence prevention.

Swinburne’s Vice-Chancellor Professor Linda Kristjanson said: “At Swinburne we celebrate and respect strength that difference creates. Swinburne is committed to achieving gender equality as an essential prerequisite for a fair workplace.”

Swinburne has for the past six consecutive years has been named an Employer of Choice for Women by the Workforce Gender Equality Agency.

“The reason behind developing Swinburne’s Gender Equality Strategic Action Plan is very simple – it will lead to a better workplace and a better society,” said Dr Andrew Smith, Swinburne’s Director of Human Resources.

“While we have worked diligently over many years to improve gender diversity at Swinburne, our Action Plan will help us realise our goal of true gender equality, where our people, regardless of gender, enjoy the same rewards, resources and opportunities within Swinburne.”

WOMEN IN TSE



Professor Karen Reynolds, Chair,
Health Technology Forum.



Dr Carrie Hillyard, Chair,
Queensland Division.



Professor Alison Ord, Chair,
Mineral Resources Forum.



Dr Anita Hill, Chair,
Victorian Division.



Professor Tanya Monro,
ATSE Vice President.

Another major initiative has been to raise the number and percentage of women elected each year to the Fellowship. In 2011 the Board set a target of 33 per cent of the new Fellows elected to be women. The assessment of merit was not changed for female nominees. The target was set on the basis that the pool of meritorious women was not being tapped for nomination.

The results were striking. In 2012 and 2013, the 33 per cent target was shown to be realistic. The percentage of women Fellows elected increased from 16 per cent in 2011 to 28 per cent in 2012 and 31 per cent in 2013. The target remains in place for 2014.

We still have a long way to go. Women only make up 10 per cent of the ATSE Fellowship. The successes in increasing the number of women elected as new Fellows over the past two years will

need to be repeated again and again to achieve balance in the total Fellowship.

ATSE has not stopped at its own four walls. It is the driving force for the Science and Technology Education Leveraging Relevance (STELR) program. This hands-on, in-curriculum program for all Year 9 or 10 students encourages exploration of the wonders and applications of science and technology.

At least 200,000 students, equal numbers of boys and girls, have completed the STELR program during the past four years. STELR modules are gender-neutral. The use of relevant contexts and hands-on inquiry-based activities engages both girls and boys. Embedded activities analysing career profiles have proven to be effective in raising the awareness of girls of the value of studying mathematics and science at the upper secondary level

of schools and of STEM-based careers.

ATSE joins forces to promote gender equality with the other Australian Academies and national and international organisations on every possible occasion. In 2010, the ATSE Board committed to uphold the United Nations Women's Empowerment Principles, which seek to empower women in all walks of life.

Achieving gender equality in applied science, technology and engineering will be a long process.

ATSE remains convinced, and now has the evidence, that it is possible to increase the numbers of women in leadership positions in the heretofore male-dominated fields of applied science, technology and engineering. Increasing visibility of both female leaders and male champions for gender equality will do much to accelerate progress.

This article was first published in Australasian Science.

VICKI THOMSON HEADS GO8

Ms Vicki Thomson has been appointed Executive Director of the Group of Eight (Go8) universities following a competitive global search.

Ms Thomson, who will succeed Mr Mike Gallagher, comes to the role after more than a decade leading the Australian Technology Network (ATN) of Universities. Ms Thomson is also a member of the Australia China Council Board and the New Colombo Plan Reference Group.

The Go8 Chair and ANU Vice Chancellor, Professor Ian Young AO FTSE, believes that the appointment of Ms Thomson will further strengthen collaboration on all fronts between Australia's leading universities and build on current international partnerships, including those in Latin America and in China with the C9 group of universities.



Vicki Thomson

DR SUSAN POND AM FTSE is an Academy Vice-President and chairs its Audit Committee. She is Chair of the Australian Initiative for Sustainable Aviation Fuels and Adjunct Professor at the United States Studies Centre at the University of Sydney. Her area of interest is the development of the advanced transportation biofuels industry. Dr Pond is a Director of ANSTO. Previous appointments include senior executive positions with Johnson & Johnson, as Director of Pharmaceutical Research and Managing Director of its biotechnology company, Johnson & Johnson Research Pty Ltd (JJR). Dr Pond was Director and then Chairman AusBiotech Ltd, from 2004–08.

WOMEN IN TSE

By Sue Stocklmayer
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Why aren't girls doing science?

There are two major reasons girls choose not to do science: they do not believe they can do it and they cannot imagine themselves in the role of a scientist.

The first question to ask is, of course, whether the assertion – that girls aren't doing science – is true. Is there still evidence that girls are turning away from science and, if so, at what point does this happen? What, if anything, should be done?

It turns out that it is indeed true at the school level for many of the sciences and engineering, and it is true for postgraduate study.

In Australia in engineering, for example, women leave the profession very much faster than men, and most women have relatively short experience. Undergraduate enrolments also reflect a gender bias for some science disciplines and for engineering.

There are many recent quantified papers testifying to this gender imbalance in most countries of the Western world¹. So something happens to women at different points in their career in the sciences.

Thinking about school first of all, there are multiple influences right from the beginning that prejudice girls against science. These include the home environment, parental attitudes, the quality of science in primary school, gender

balance in the classroom, and so on.

I would like to focus, however, on the point of choice – Years 9 and 10 in Australia – to try to assess what the major influences might be in turning bright and able girls away from science.

According to authors Lyons and Quin² it is nothing to do with young people losing interest in science, or a perception that scientists are not well paid. The major reasons for girls not choosing to do science are twofold: they do not believe they can do it, and they cannot imagine themselves in the role of a scientist. The importance of role models is thus critical.

I believe there is another important factor that we also need to think about when considering all students who choose not to take up a STEM career. Hints can be found in a major project called ROSE³, originating from the University of Oslo but encompassing 25 countries and 25,000 15-year-olds (Australia is not part of it but we can predict where we might fit).

All 'developed' nations in this project found that there was high support for science amongst their teenagers – but it was "not for me". These teens said that

they wanted to "work with people rather than 'things'", which seems to suggest they believe science is not about people.

Therefore we are losing not only the girls, but also those boys who have an interest in human endeavours. Thus science itself is sending the wrong message at school level, compounded by lack of hands-on experience and an absence of real-world applications.

Girls drop out early. This trend then continues across the undergraduate years and beyond. The Dean of Stanford¹ believes that the reason for this is often because they have low self confidence and feel the career is not for them because they "don't see people like them". There is a powerful sense of not belonging.

What if they do opt for a career in STEM? According to Sharon Bell⁴:

“The reasons for the low representation of women in science and technology can be separated into two broad categories. First, horizontal segregation of women in the various science disciplines based on perceptions regarding women's innate ability in science and mathematics, societal attitudes ... and

SCIENCE 50:50 - WHY S&T IS FOR GIRLS

Science 50:50 aims to inspire Australian girls and young women to pursue research careers in science and technology for an innovation-driven future. It makes the simple point: since half the population is female, why not half the scientists and technologists?

By engaging girls from high school with the power of science and technology to solve complex problems and transform lives, and by introducing Australian innovators who are doing just that, Science 50:50 can help recalibrate the gender balance.

With only 10 per cent of senior academic positions in science faculties currently held by women and even fewer senior role models within CSIRO and industry, that means helping clear an unbroken pathway for girls from high school, through university and into academic and industry research careers.

As Australian high school girls are acutely under-represented in physics and chemistry, the so-called hard sciences that underpin so many relevant university-level courses, girls need to hear real stories from real people whose own pathways to success make it abundantly clear that science and technology really is for girls.

We are living in a science- and technology-dependent era. The link between innovation and national economic prosperity is now well documented, as is the critical role of education in building the scientific and technological skills and literacy the next generation will rely on. Girls can't be left behind.

Science 50:50 is led by UNSW ARC Laureate Fellow Professor Veena Sahajwalla FTSE, who is driving innovating to create new 'green' materials. It is supported by Professor Sahajwalla's Georgina Sweet Fellowship and UNSW, and involves:

- Creating a Science 50:50 web portal, run by UNSW science and technology students, to introduce and showcase Australian

WOMEN IN TSE

job security ... Second, vertical segregation, generated by the organisational culture of the workplace ... "

Perceptions about ability and suitability of women in science are not new, and persist. According to Evelyn Fox Keller⁵, the very origins of western science in the days of the Enlightenment and the foundations of the Royal Society carried inherent bias against the presence of women and, eventually, a belief that women's brains could not cope with complex science and mathematics.

Thus if we are to address this imbalance, we have to deal with centuries of prejudice and practice. In 2013, the *Nature* editorial accompanying the special issue on gender carried comments from bloggers which included, from a male contributor: "The real reason for the gender asymmetry in some sciences is that women and men naturally have different interests. And the reason for the higher number of male Nobel prizes is the higher variance in the male distribution of various qualities, including IQ, with respect to females."

The Royal Society itself only began to look at this problem in the 1940s and today just five per cent of its Fellows are women. Percentages in our Academies are just as diabolical. (Women comprise 10 per cent of the ATSE Fellowship – *Editor*.)

The result of all this is that we are not drawing on our full intellectual capital. It is not just about the figures. Women bring to



High school students, participating in a UNSW Women in Engineering Camp, check solar panels on the roof of the Sydney Theatre Company.

STEM research different world views and different attributes. More women in science will broaden and diversify scientific culture and ask different questions. They bring other ways of understanding the world.

If we are to change all this, we need to change the way we present science as an objective, disconnected activity. We need to cultivate and cherish young female role models and make sure that they are rewarded for taking the opportunity to talk to aspiring and able young women.

We need to look at the rare examples of success elsewhere and analyse what we can do in Australia, particularly concerning career paths. The formation

of the Science in Australia Gender Equity Forum, announced on 31 July 2014, plans to examine successful programs such as Athena SWAN, in the UK, to see whether similar initiatives can be set up here.

It will not be enough to fix everything, but it will be a start.

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PROFESSOR SUE STOCKLMAYER AM is the Director of the Australian National Centre for the Public Awareness of Science at ANU, where she directs a full undergraduate and graduate program in Science Communication. She grew up in Zambia, graduated in physics and chemistry from the University of London and worked on the Zambian copper mines as a chemist before migrating to Australia in 1982 after co-directing an extensive hands-on science program for rural village students in Zimbabwe. In 1994, she completed her doctorate and moved to the Australian National University. She was awarded an AM in 2004 for science communication initiatives.

innovators, to link aspiring young women to dedicated 50:50 mentors and internship opportunities and to enable girls in science to start talking via blogs and social media;

- Launching a Science 50:50 New Innovators competition offering university scholarships for the most original and innovative ideas for solving real-world problems;
- Engaging girls with science and technology via school visits, the media and online resources, and engaging universities, research organisations and industries; and
- Recruiting an expert Advisory Board from Australia's leading science and technology industries.

You can help with stories and support. Science 50:50 aims to build a network of speakers and mentors and to broker new internship opportunities for female students across Australia's science and technology industries.

**Do you know an inspiring scientist?
Can you publicise 50:50 across
among your peers?
Can you host a young researcher
or provide other practical support?**

**If so, please contact Professor Sahajwalla
(veena@unsw.edu.au, 02 9385 4426).**

WOMEN IN TSE

Women researchers are Tall Poppies

Women took out half the South Australian 2014 Tall Poppy Awards for young scientists, which recognise individuals who combine world-class research with a passionate commitment to communicating science and who demonstrate leadership potential.

Eight exciting young scientists were chosen from disciplines spanning health and environmental research, antibiotic development and fluid mechanics and four were women:

- Dr Stephanie Reuter Lange, UniSA School of Pharmacy and Medical Sciences, researches how drugs are processed by the body and whether factors such as weight or age contribute to differences in the treatment response between patients;
- Dr Margarita Tsiros, UniSA's School of Health Sciences, studies the impact of obesity in children to improve their day-to-day physical functioning, disability and wellbeing;
- Dr Hannah Brown, Robinson Research Institute, University of Adelaide, researches the origins of diabetes and related disorders in very early life; and
- Dr Deirdre Zander-Fox, Repromed and University of Adelaide's School of Paediatrics and Reproductive Health, focuses on improving IVF pregnancy rates through laboratory technology by optimising embryo freezing and culture media design.

Dr Cristian Birzer, University of Adelaide, won the top SA Young Tall Poppy Science Prize for research that could save the lives of millions of people across the developing world who die as a result of doing something we all take for granted – simply cooking a meal.

Dr Birzer's research involves taking the complex science of combustion and fluid mechanics, plus the creativity of engineering, to develop affordable solutions to reduce harmful emissions from solid fuels such as dung and wood. Dr Birzer's group will also examine affordable solutions to treat pathogens in water.

The Tall Poppy Campaign was established in 1998 by the Australian Institute of Policy and Science to promote public awareness of Australia's intellectual achievements. An important component of the campaign is the Young Tall Poppy Science Awards, which recognise the achievements of outstanding young researchers in the sciences including technology, engineering, mathematics and medical research.

NEW CHIEF FOR AGRIFOOD SKILLS

Ms Anwen Lovett is the new Chief Executive Officer of AgriFood Skills Australia.

Ms Lovett will take up her new role in mid-September, replacing Mr Arthur Blewitt, who is retiring from the position. She is currently the Executive Manager of the Rural Industries Research and Development Corporation (RIRDC) and has held senior roles at the Australian Solar Institute, Land and Water Australia and the National Farmers Federation



Swara (left) and Neera Jain.
PHOTO: GRANT TAYLOR

SLOW BURNING TO CAPTURE CARBON

Dr Adriana Downie, from Pacific Pyrolysis Pty Ltd, won the 2014 3M Eureka Prize for Emerging Leader in Science for her work in slow-pyrolysis technology – converting waste products into bioenergy and biochar.

Biochar is a soil improver with potential to mitigate climate change by absorbing carbon from the air. It's made by slowly burning straw, sawdust and other plant waste.

The scientific and commercial challenges are significant – with different disciplines and industry sectors involved.

Dr Downie is taking on the roles of scientist/engineer, entrepreneur and communicator. She has taken a lead role in applying for research funding, successfully gaining over \$5 million in government funding. And she has been instrumental in organising biochar conferences, public regional meetings, and researcher networking sessions.

She is driven by a clear vision of contributing to a sustainable future.

Dr Downie is also inspired by the knowledge that man-made soil has been used for millennia; thousands of years ago in the Amazon basin, farmers seeded soil with charcoal, bio-matter and pottery shards, producing dark, rich soil more fertile than the surrounding land.

"Adriana has worked tirelessly to develop biochar technology and to communicate the technology's potential to those outside the field," Australian Museum Director and CEO Kim McKay said. "Her enthusiasm and passion for the challenge ahead is nothing short of infectious."

This is not the first time Adriana's leadership skills have been recognised. She was a finalist for the Eureka Prizes for Young Leaders in Environmental Issues and Climate Change (2008), and Emerging Leader in Science (2012), and was named one of the country's next 100 emerging leaders by *The Australian* in 2009.



Adriana Downie

TWIN SUCCESS FOR MEDICAL STUDENTS

Twins Neeranjali and Swaranjali Jain, who are enrolled in Honours in Medicine at UNSW, were jointly awarded this year's Jamieson Award by the Australian Federation of Graduate Women NSW.

It's not the first time they have shared such honours, graduating as joint dux of Canberra Girls Grammar School and each winning multiple Dean's awards at university.

Both are violinists in the UNSW Orchestra and they share a passion for community work and volunteering.

WOMEN IN TSE

L'Oréal Fellows named for \$25,000 prizes



Cara Doherty



Vanessa Kellermann

Three young Melbourne scientists have been named as the 2014 L'Oréal For Women in Science Fellows. They were chosen from 186 applicants by a panel of eminent scientists.

The \$25,000 Fellowship funds are intended to further the Fellows' research and may be used for any expenses they incur, including childcare. The program is part of L'Oréal's global support for women in science. Dr Cathy Foley PSM FTSE was one of the eight-woman judging panel.

The 2014 winners are: Dr Elena Tucker, geneticist, Murdoch Childrens Research Institute; Dr Vanessa Kellermann, evolutionary biologist, Monash University; and Dr Cara Doherty, materials scientist, CSIRO.

Dr Elena Tucker has brought peace of mind to families affected by rare energy disorders. She's found genes responsible for some of these diseases. Now, with the support of her 2014 L'Oréal For Women in Science Fellowship, she will look at hundreds of individual genomes to determine the causes of sex-determination disorders. For the thousands of families affected by these rare disorders Elena's work provides an understanding of the causes and opens a path to management and to potential treatments.

Dr Vanessa Kellermann is working with native fruit fly species from Tasmania to tropical Queensland to find out how insects will cope with climate change. She has already demonstrated that tropical flies are more vulnerable to change in the long term – they don't have the genetic capacity to evolve quickly. Now, with her L'Oréal For Women in Science Fellowship, she will explore how flexible they are in the short term – how individual insects can respond to change during their lifetimes.

Dr Cara Doherty is developing new technologies that could transform water filters, batteries and medical sensors, and clean up carbon emissions. She has a vision for a new manufacturing industry for Australia. She works with metal-organic framework (MOF) crystals that are challenging to make and even harder to deploy. She uses antimatter (positrons) and synchrotron light (X-rays) to measure the crystals and their properties. Then she uses her patented technique to imprint useful shapes for devices.

With the help of her L'Oréal For Women in Science Fellowship she will investigate how to take the next step: to develop the 3D structures that would be needed for a smart water filter.

NEW INDUSTRY INTERN PROGRAM LAUNCHED

Victoria has launched an innovative industry internship program by veski and AMSI Intern. The partnership will connect female honours and masters students with Victorian industry and government agencies to address a research problem currently facing their organisations.

The 'Inspiring Women' industry internships seek to support, advance and inform Victorian women through partnerships with government, industry and academia. The program will also provide eligible Victorian SMEs, government agencies and large businesses across all industry sectors with access to one of 10 funding grants supported by the Victorian Government.

Victorian Government Lead Scientist Ms Leonie Walsh FTSE said: "These internships will not only provide career choice for female scientists, they will promote links between academia and industry and help meet the current and future skills needs of the state".

The Government's veski program includes five of Victoria's most prestigious science and innovation awards: the veski innovation fellowships; the Premier's Award for Health & Medical Research; the Victoria Prize for Science & Innovation and the Victoria Fellowships; and the Victorian Postdoctoral Research Fellowships.

AMSI Intern is the Australian Mathematical Sciences Institute's university and industry collaboration that connects business and other organisations to research expertise in Australia's universities. It is a national program that links postgraduate students and their university supervisors across all disciplines with industry partners through short-term (four to five month) research internships.

•veski is a charitable institution working to enhance Victoria's intellectual capital through a program of fellowships, awards and international networks.



Elena Tucker

Bureau updates data link ahead of supercomputer

One of Australia's fastest data links is now giving weather forecasters better access to vital weather information. The Bureau of Meteorology has upgraded its data link to more than twice the speed of its previous link, allowing the agency to now move vast amounts of data at the speed of light.



Rob Vertessy

Bureau of Meteorology Director Dr Rob Vertessy FTSE said the new data link would enable the BoM to further improve the accuracy and timeliness of its weather forecasts and warnings, and increase the agency's Information and Communication Technology (ICT) resilience.

The BoM will soon go to the market to purchase the supercomputer and data centre, announced by the Australian Government as part of the 2014-15 Federal Budget.

"The data link upgrade and supercomputer project are elements of a significant IT transformation being undertaken by the Bureau at this time, including the replacement of weather forecasting and flood forecasting systems, the development of a new storm surge forecasting system and the introduction of several new water information products and services," Dr Vertessy said.

The upgrade has increased the connection between the BoM's two main data centres from 80 gigabits per second (Gbps) to 200Gbps.

FIVE AUSTRALIANS MAKE QS TOP 50

Five Australian universities were ranked in the top 50 in the latest QS world university rankings – ANU (25), Melbourne (33), Sydney (37), UQ (43) and UNSW (48).

Another three were ranked in the top 100 – Monash ranked at 70, UWA 89 and Adelaide 100.

No Australian university was ranked in the second 100 – but five made the third 100 – Macquarie was ranked 254, Newcastle 257, UTS 264, Wollongong 283 and QUT 285.

RMIT was ranked 304, Griffith 324, Curtin 331, UniSA 333, James Cook 350 and Deakin 360.

La Trobe and Tasmania were listed at 400-410, Bond University at 471-480 and Flinders at 481-490. Charles Darwin was ranked at 551-600, along with Murdoch and Swinburne.

Canberra and Western Sydney were ranked 651-700.

Charles Sturt was ranked 701+ – along with Edith Cowan, New England and Southern Queensland.

The top 10 rankings went to US and English universities – MIT (1), Cambridge (2), Imperial College London (3), Harvard (4), Oxford and University College London (5), Stanford (7), Caltech (8), Princeton (9) and Yale (10).

Robots roam the National Museum of Australia.

GLAM INDUSTRY MUST GO DIGITAL – CSIRO

An analysis of Australia's galleries, libraries, archives and museums (or GLAM industry) says its digital innovation is inconsistent and isolated and should be a 'core' aspect, rather than an 'add-on' activity.

The CSIRO report, conducted in partnership with the Smart Services CRC, is based on consultation with representatives from state, national and local galleries, libraries, archives and museums, researchers and international experts.

Titled *An Innovation Study: Challenges and Opportunities for Australia's Galleries, Libraries, Archives and Museums*, it provides a roadmap for the industry in order for it to maximise the potential of the digital economy.

With Australia's rapid uptake of online and mobile platforms, people are now choosing to access and share information in very different ways, but Dr Michael Bruenig, Acting Director of CSIRO's Digital Productivity Flagship, says many of Australia's cultural institutions have not kept pace with this change.

"The report identified that only a few organisations have made fundamental changes to their operations that would allow them to place digital services at their core, rather than as an 'add-on' activity," he said.

The few cultural institutions that were embracing digital technology were reaping the benefits, he said.

"For example, it is now possible to visit the National Museum virtually via a guided robot. This innovation means school students in regional Australia are able to explore exhibits and engage with the museum, when they otherwise would not have the opportunity to," Dr Bruenig said.

The report also showed that Australia is falling behind international best-practice in digitising more than 100 million artworks, books and audio-visual items. According to Dr Bruenig, this slow progress means we risk losing public visibility of cultural and heritage material of significance.





Gordon Wallace

ACES gets another seven years' cash

The ARC Centre of Excellence for Electromaterials Science (ACES), based at the University of Wollongong, has secured a further seven years of funding as an ARC Centre of Excellence in the latest round of funding commencing in 2014.

"In its first seven years – under the strong guidance and leadership of Centre Director and ARC Laureate Fellow, Professor Gordon Wallace FTSE – this Centre has produced some outstanding research outcomes and cutting-edge innovations," said Australian Research Council Chief Executive Officer, Professor Aidan Byrne.

"Some of ACES' most significant breakthroughs have included the development of nanotube yarn that can power implantable biomedical devices, artificial muscles with super-human strength using fishing line, and the acceleration of 3D printing techniques that will deliver solutions to a number of medical challenges.

"ACES has built an internationally-recognised research program and reputation in materials science. Its continuation as a Centre of Excellence will enable the translation of this knowledge into devices that will have an impact on the whole Australian community, and around the world."

ARC Centres of Excellence are prestigious foci of expertise through which high-quality researchers maintain and develop Australia's international standing in research areas of national priority.

ResQu CHOPPERS HELP FORESTS FIGHT WEEDS

Australia's rare and precious rainforests, like the iconic Daintree, could have an unexpected aerial ally in the battle against weeds – autonomous helicopters.

Two Project ResQu helicopters developed by CSIRO have completed trial flights near Cairns, locating weeds like the dreaded 'purple plague' (*Miconia calvenscens*) faster and more reliably than ever.

Developed by robotics researchers at CSIRO, in partnership with Biosecurity Queensland, the unmanned helicopters found weeds using sophisticated imaging technology. The helicopters are safer and a more convenient way of mapping weeds in remote and difficult terrain.

CSIRO Biosecurity Flagship Science Director, Dr Gary Fitt FTSE, said

access to dense rainforests was difficult for people but all-too-easy for weeds which get carried in by animals or blown in from gardens or farms.

"*Miconia* is among the worst of a number of weeds that pose a significant threat to Australia's precious rainforest remnants," Dr Fitt said.

"Unless detected and eradicated early, they can cause irreversible damage to our native plant and animal populations. In the biosecurity space effective surveillance is critical – we need to be able to detect incursions quickly and accurately.

"Technologies like the autonomous helicopter or other autonomous platforms provide us with another tool in the fight against these biological invasions."

INVESTIGATOR IN HOBART FOR FINAL FIT-OUT

The new Marine National Facility research vessel *Investigator* has arrived at its home port of Hobart for its final fit-out of scientific equipment.

With almost \$20 million worth of scientific equipment, the 94-metre ship is capable of mapping the sea floor at any depth, collecting weather data 20 kilometres into the atmosphere, analysing fish species with sonar, and revealing the composition of the sea bed 100m below the sea floor.

Executive Director of CSIRO's Future Research Vessel Project, Ms Toni Moate, said the ship's scientific capabilities were extensive.

"We now have the exciting task of working with the marine science community to explore the different ways we can combine the data collected on board *Investigator*, to answer important research questions," Ms Moate said.

FLOATIES FOR CHOPPERS

The inventor of a helicopter buoyancy device that inflates within a second, and is built to a lightweight, bolt-on/bolt-off design, has been awarded the DSTO Eureka Prize for Outstanding Science in Safeguarding Australia.

Engineer and ex-Navy diver Tim Lyons from One Atmosphere developed the Pegasus Aircraft Buoyancy System (ABS) – designed to save lives following a helicopter crash at sea, when the crew is more at risk from drowning in a fast-sinking craft than from injuries caused by the crash itself.

The Pegasus activates automatically and the airbags inflate incredibly quickly on crashing – inflating to full volume in less than a second. This keeps the cockpit properly oriented and held above the waves, so that pilot and passengers can escape. Inflation systems this fast have previously proven too unwieldy and heavy for everyday use, but the innovative gas-supply system eliminates heavy gas cylinders.

Pegasus was designed for the Australian Army's new fleet of Tiger helicopters – which will be spending more time flying over sea now that the Navy is building two big helicopter ships – but the device can be easily adapted for other craft.



Tim Lyons

By Chris Greig
chris.greig@uq.edu.au



The CCS conundrum: more investment urgently needed

Continued investment in long-life assets that burn fossil fuels means that significant CO₂ emissions are likely to be locked in for decades.

The prosperity and improved living standards that the world's industrialised economies have experienced over the past two centuries have been largely driven by our ability to harness low-cost energy provided by fossil fuels.

We currently burn oil, gas and coal to provide this energy at the equivalent rate of 12.5 billion tonnes of oil equivalent, an amount which is rising.

But over the past two decades there has been a growing body of evidence to suggest that anthropogenic CO₂ produced as a result of burning these fossil fuels is driving fundamental changes to the earth, with much of the focus around increasing average temperatures.

According to the Intergovernmental Panel on Climate Change, the risks to ecosystems, economies and social wellbeing become unacceptable at an average global temperature increase of 2°C above the Preindustrial Period. This level of temperature rise is generally associated with an increase in atmospheric CO₂ concentration to 450 ppm.

Much of the climate modelling suggest

that current rates of CO₂ emissions (36 billion tonnes in 2013) will see an increase of more than 4°C in average global temperature by the end of the century with disastrous consequences.

Notwithstanding these warnings, the world continues to invest in fossil-fuel-based power generation, heating and industrial production of cement, steel, fertilisers and various chemicals. Much of the new investment is unlikely to be retired early and so at least a portion of these emissions may be locked in for decades.

At current trends of increasing energy use, emissions will rise to 55 billion tonnes by mid-century, which in turn could see average global temperature rises of 6°C.

CCS crucial

It is within this context most credible projections envisage a suite of mitigation technologies including energy efficiency, fuel switching (for example, coal to gas), renewables, nuclear, and carbon capture and storage (CCS). Indeed, CCS is projected by many to play a crucial role in a carbon-constrained world, being the only technology currently able to significantly

reduce stationary source emissions from the use of fossil fuels (coal and gas).

Figure 1, from the IEA's *Energy Technology Perspectives* (2014), suggests that to keep global average temperatures within 2°C of preindustrial levels (its so-called 2DS Scenario) CCS will account for 14 per cent of the cumulative CO₂ mitigation task involved in reducing from the current trend rate (the so-called 6DS scenario), between now and 2050. This is equivalent to 17 per cent of the projected business as usual annual emissions in 2050.

The CCS and other decarbonisation technology 'wedges' illustrated in the graph on the right in Figure 1 present an elegant picture of where we need to get to. Such illustrations are routinely presented at the front of almost every presentation or research proposal advocating favour or funding for a particular low-carbon technology or project.

What the wedges fail to portray, however, is the true perspective of the scale and implementation challenge.

The challenge

In the case of CCS, that challenge looks like this: deploy industrial capture of anthropogenic CO₂ and geosequestration to a rate of over three billion tonnes a year by 2035 and almost seven billion tonnes a year by 2050. To put these targets in perspective, this would involve a ramp-up of CCS to the equivalent scale of global natural gas production within 20 years and global oil and gas production within 35 years!

When we consider that those industries achieved such levels of production over time periods at least twice that indicated by the decarbonisation wedges, and with significant positive economic drivers, one has to wonder just what combination of circumstances – social,

Figure 1 Contributions to annual emissions reductions between the 'six-degrees scenario' (6DS) and the 2DS.

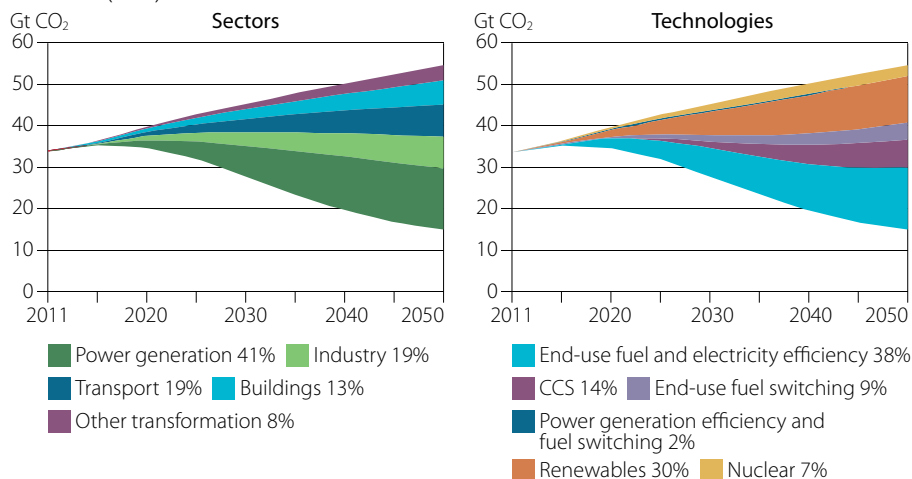
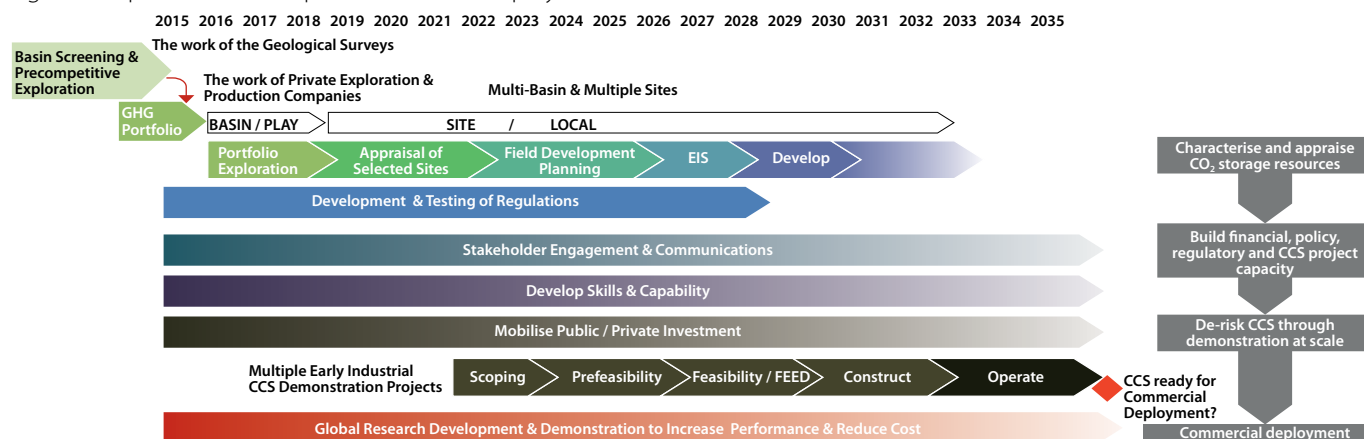


Figure 2 A possible roadmap to commercial deployment of CCS in Australia.



technological, environmental, economic and/or political – might be required to achieve such expansion of CCS.

Even with the necessary drivers to motivate deployment, there exists a sequence of necessary development activities that must be undertaken to achieve deployment. These include finding, characterising, permitting and developing storage sites, undertaking feasibility studies for integrated CCS projects and ultimately designing, permitting, financing and constructing pipelines and power or industrial facilities incorporating CO₂ capture.

All of these activities must occur notwithstanding a disappointing history during which the deployment of large-scale integrated CCS demonstrations for the sole purpose of emission reduction has fallen far short of the ambitions held for the technology by policy-makers and industry.

According to Greig and Garnett in the IEA's 'Insights' series, (CCS, 2014), such disappointment has been driven by the complexity of CCS investments which is caused by:

- 1 A combination of public and private funding, involving parties with varying technical capability and tolerances to financial and reputational risk preventing alignment of goals around commercial returns and risk exposure.
- 2 The requirement for significant at-risk investment in CO₂ storage exploration and appraisal, selecting a concept and detailed design of process and capture facilities before taking a Final Investment Decision on a large (sometimes multi-billion-dollar) investment in the integrated project.

3 The lack of a commercial model to support private sector equity investment for CO₂ storage, which has driven enormous exploration and appraisal investment in traditional oil and gas resources.

4 The interdependence of investors in CO₂ storage resources with investors in capture technology associated with the power or industrial processing sectors for the CO₂ source and revenue and their differing investment decision criteria.

5 The relative immaturity of key capture technology, especially for power generation, requires commercial lenders to lay-off the technical risk, especially for integration (including counter-party) risk.

6 The higher costs and potentially lower availability (at least while ramping-up) of CCS projects, especially for power plants operating in highly competitive electricity markets.

CCS in Australia

Australia is endowed with world-class coal and gas resources. Despite significant policy incentives for renewables, we remain reliant on these fossil fuels for about 87 per cent of electricity generation, which is actually higher than the world average of about 65 per cent.

Australia should arguably be an early mover and may provide a case study for the rest of the world. In Figure 2, we map a potential approach to deployment in Australia using a measured, risk assured, but not financially constrained, approach.

For example, we propose that investment in construction or even feasibility for capture facilities lags the development of confidence in CO₂ storage resources but that early demonstrations

are not constrained by requirements for a business case or availability of capital. This conceptual roadmap would suggest that CCS might be ready for commercial deployment in Australia by 2035.

Importantly, it highlights the scheduling of a number of critical earlier activities which are likely to require significant investment – potentially amounting to some \$10 billion over the next 20 years.

Noting the absence of a business case for CCS, it is likely that the much of this investment would need to come from government. Today the total forward estimates for CCS expenditure by Commonwealth and State governments is less than 10 per cent of this figure. Similar funding gaps are evident in most fossil fuel-dependent countries.

And so we have the 'CCS conundrum' – where continued investment in long-life assets that burn fossil fuels means that significant CO₂ emissions are likely to be locked in for decades; CCS is so far the only technology available to mitigate these emissions at scale; but the lead times and high front-end investment in the risky business of exploration and appraisal of subsurface storage resources suggests that the necessary deployment is likely to lag expectations (and the timeframes sought by climate scientists) by a decade or more.

This is not a reason to discount the importance of CCS because, thus far, the pace of deployment of all carbon-mitigation technologies has been similarly disappointing.

The CCS conundrum simply tells us that more investment, especially in CO₂ storage exploration, is urgently needed. In

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Links to strengthen Defence research

A new partnership program between the Department of Defence and the innovation sector aims to strengthen and enhance the impact of Defence science research in Australia.

The Defence Science Partnerships program, led by the Defence Science and Technology Organisation (DSTO), will enable Australian universities to work in a coordinated way with Defence and national security agencies on collaborative research projects.

The program complements DSTO's Industry Alliance program, which forges closer collaborative research and development activity with industry.

"This program provides a uniform model for universities to engage with Defence on research projects and ensures a consistent approach to intellectual property and cost sharing," Chief Defence Scientist Dr Alex Zelinsky FTSE said when launching the program.

The program was developed in consultation with a working group from the University of Adelaide, RMIT University, the Australian National University, the University of Queensland, the University of New South Wales, Monash University, Charles Darwin University and the University of Tasmania.

Involvement in the program will enable universities to leverage funding from DSTO and other sources, and share research infrastructure.

"The program's strength lies in its potential to harness

Australia's world-class research and better align it to Defence priorities through increased collaboration and a greater sharing of resources and infrastructure," Dr Zelinsky said.

"Through the partnerships program, we will work with our university partners to also promote careers in science, technology, engineering and mathematics (STEM) and increase the number of STEM students."

At the same time, the Defence Science Institute (DSI) has partnered with the AMSI Intern program to access high-end quantitative and analytical expertise, from within Victoria's leading universities, to benefit DSTO and the defence industry.

DSI aims to connect highly qualified PhD researchers – from across all disciplines – with industry partners to address a research challenge currently facing their business.

DSI was established in 2010 at the University of Melbourne and is jointly funded by the Victorian Government, DSTO and the university. It harnesses the capabilities of Victoria's universities to deliver integrated multidisciplinary solutions for the defence sector and facilitate the growth of defence science research networks between academia, DSTO and defence industry.

AMSI Intern is a university-industry collaboration that connects business and other organisations to research expertise in Australia's

universities, linking postgraduate students and their supervisors across all disciplines with industry partners through short-term (four- to five-month) research internships.

BOOST FOR SOLAR-DIESELHYBRID POWER

The Australian Renewable Energy Agency (ARENA) has announced \$450,000 funding to support a \$1.4 million pilot-scale roll-out of an innovative renewable energy solution.

ARENA CEO Ivor Frischknecht said the construction company Laing O'Rourke would be constructing, setting up and packing down the world's first fully redeployable large-scale solar-diesel hybrid power plant.

The first deployment will be a 1MW plant with 134KWp of solar photovoltaics at Laing O'Rourke's 350-bed Combabula accommodation village in regional Queensland, which will house workers during the construction phase of a major resource project.

"ARENA supported Laing O'Rourke to undertake initial design work into this technology and we are very pleased to see it moving into the demonstration stage," Mr Frischknecht said.

"The speed at which this game-changing solution has progressed from the drawing board to the field is a testament to the clever Australian design and its potential to bring more renewable energy to off-grid Australia."

Mr Frischknecht said the permanent nature of fixed-framed solar installations is currently a substantial barrier to their use off-grid, particularly in mining operations and other short-term and medium-term ventures.

"The plant will consist of transport-friendly, container-sized modules, including a control centre and inverters with external, pre-wired connections to allow fast, easy set-up and pack down," Mr Frischknecht said.

"A semi-portable hybrid system like this carries enormous potential – it may provide industries and communities in regional and remote locations with a viable renewable energy alternative and could equally be used to assist in international relief efforts."

Laing O'Rourke is an A\$8 billion global construction company and the largest privately owned construction and engineering firm in Australia, covering building construction, railway services, materials handling, marine and civil infrastructure and a range of support services to clients in the oil and gas, resources, transport, defence, health, commercial and industrial sectors.



Alex Zelinsky speaking at the Defence Science Partnerships program launch.

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the absence of a strong carbon price signal, such investment must be underwritten by government.

Sources: Intergovernmental Panel on Climate Change (IPCC), International Energy Agency (IEA), Bureau of Resources and Energy Economics (BREE).

PROFESSOR CHRISTOPHER GREIG FTSE is Professor Energy Strategy and Director, UQ Energy Initiative, University of Queensland. He is an innovator and business leader who has made outstanding contributions in the sugar, mining and energy industry sectors. His patented inventions in the sugar and kaolin processing industries have had enduring industrial impact. His engineering project management skills have had significant economic impact within Australia and abroad. He is also internationally recognised for his vision and leadership in low-emissions energy, especially carbon capture and storage.



PHOTO: GRANT TURNER

Australia's first fuel cell bicycle

University of NSW researchers have built an Australian-first bicycle that can take riders up to 125 kilometres on a single battery charge and \$2 of hydrogen.

The Hy-Cycle, created by a team including Associate Professor Kondo-Francois Aguey-Zinsou and Technical Officer Paul Brockbank from the School of Chemical Engineering, is powered by a hydrogen fuel cell, which provides electrical assistance with pedalling, enabling the rider to easily travel long distances or up hills.

The Hy-Cycle's main innovation is the demonstration of hydrogen as a clean and safe energy.

Hydrogen for the Hy-Cycle is carried in a 2.5-kilogram canister that sits adjacent to the pedals. The canister feeds the fuel cell, which is located under the seat and continuously recharges a lithium-ion battery. A standard metal hydride inside the canister enables safe, user-friendly storage of the hydrogen, UNSW says.

"What we've been trying to develop in my laboratory is a new way to store hydrogen in a very compact fashion," Associate Professor Aguey-Zinsou says.

"Hydrogen storage can be a problem because it's a light gas, but with the material and the technology we've developed you can actually make it safe to store and use."

One kilogram of the standard metal hydride is capable of storing 100 litres of hydrogen, but Associate Professor Aguey-Zinsou and colleagues at UNSW are now developing borohydrides that could store the same amount of hydrogen using just 50 grams of storage material.

The researchers believe hydrogen power should be afforded the same opportunity to shine as other renewable energy technologies, such as solar.

"We should not be waiting to harness hydrogen fuel cell technology when it is ready now," Associate Professor Aguey-Zinsou says.

UNSW Dean of Engineering, Professor Graham Davies FTSE, tries out the Hy-Cycle.

ARENA PUTS \$21.5 MILLION INTO 12 SOLAR PROJECTS

The Australian National University received \$8.7 million funding for five of the 12 R&D projects to receive funding in the first round of the Federal Government's ARENA funding program.

The University of NSW received \$6.9 million for three projects and the University of Technology, Sydney, was awarded \$750,000 for a single project. CSIRO was awarded \$4.6 million for three projects.

The total value of the 12 solar energy projects is estimated at \$70.5 million, of which the ARENA funding will provide \$21.5 million.

Announcing the ARENA grants, the Parliamentary Secretary to the Minister for Industry, Mr Bob Baldwin, said the funding was being leveraged by strong domestic and international industry investment.

Mr Baldwin said Australia already had a reputation for delivering world-leading photovoltaic and concentrating solar thermal technologies.

"These projects represent the very best of the best. They were selected from a highly competitive R&D round promoting excellence in solar research, and are set to advance renewable energy knowledge and expertise in Australia.

"This investment will ensure we continue to grow this important export base as well as advancing the nation's technological capability and reputation for delivering groundbreaking renewable energy solutions that will ensure a diverse energy future for Australia."

The Australian Government established ARENA as an independent agency on 1 July 2012 to make renewable energy technologies more affordable and increase the amount of renewable energy used in Australia.

PHOTO: CSIRO



The solar tower and field at the CSIRO's National Solar Energy Research Centre in Newcastle.

Fresh Science becomes FameLab Australia

Dr Michael Smout, from James Cook University in Cairns, is the inaugural winner of the FameLab Australia award, previously known as the Fresh Science Awards.

He was chosen winner at the 2014 national final at the Western Australian Maritime Museum by a panel of judges that included Professor Lyn Beazley AO FTSE (former Chief Scientist of WA) and Dr Ian Macleod FTSE (Executive Director of WA Museums Fremantle and Maritime Heritage).

The national final event saw the 12 FameLab Australia finalists explain their research in dynamic three-minute presentations, which were entertaining and often fascinating. The other 2014 finalists were:

- James Makinson, University of Sydney;
- Nick Roden, University of Tasmania and CSIRO;
- James Aridas, Monash University;
- Prue Cormie, Edith Cowan University;
- Vince Polito, Macquarie University;
- Lydia Tong, University of Sydney;
- Francis Torres, University of Western Australia;
- Niraj Lal, Australian National University;
- Lisa Schafranek, SAHMRI;
- Tim Brennan, AIBN, University of Queensland; and
- Linden Servinis, Deakin University.

JETLAG PATCH MAY PREVENT NEWBORN BRAIN DAMAGE

A simple and affordable 'jetlag' skin patch could help prevent disabilities in and deaths of millions of babies worldwide each year by reducing the brain damage caused by low oxygen during birth.

Monash University PhD student James Aridas and his colleagues at Monash Institute of Medical Research and Prince Henry's Institute (MIMR-PHI) in Melbourne have found that melatonin patches, commonly used to treat jetlag in the US, can reduce damaging free radicals and subsequent brain-cell death when they are administered in the hours after birth asphyxia has occurred.



JAMES ARIDAS



(From left) Ian McLeod, Nick March (Country Director, British Council) and Lyn Beazley focused on their judging duties.

Fresh Science is a national competition that has been helping early-career researchers publicly share their stories of discovery for the past 12 years. In 2014 Fresh Science partnered with the British Council to present the inaugural FameLab Australia. FameLab is a global competition for early career scientists.

We'll cover their work in *Focus*.

Melatonin is a hormone secreted by the brain's pineal gland that helps neutralise free radicals in the body. Free radicals are unstable molecules that are a natural byproduct of the body's use of oxygen to create energy.

The discovery could help change the fate of around 300 Australian babies who develop disabilities and neurodevelopmental disorders after birth asphyxia each year, as well as that of millions of babies in developing countries where treatment is almost non-existent.

James and his supervisors Dr Suzie Miller and Professor Graham Jenkin undertook preclinical studies in animals with help from the Bill & Melinda Gates Foundation, and they will begin clinical trials of the patches in India next year.

James and his team used MRI scans to show that the melatonin treatment improved brain metabolism and reduced cell death when it was given to lambs after birth asphyxia.

He says the melatonin patches are easy to use and can be stored without refrigeration, facilitating their use in remote rural areas and developing countries.

James won the Victorian final of the inaugural 2014 Australian FameLab competition.

FUTURE JET FUEL WITH AN ORANGE FLAVOUR

Queensland researchers are persuading baker's yeast to produce orange-flavoured renewable jet fuel from sugar.



TIM BRENNAN

Timothy Brennan and his colleagues at the University of Queensland's Australian Institute for Bioengineering and Nanotechnology (AIBN) have helped genetically engineered yeast to evolve to make an oil called limonene, which is found naturally in lemons and oranges, and also happens to be an efficient jet fuel.

They've worked out how to get the yeast to make more oil without killing itself in the process – an important step in scaling-up biofuel production so that it can become a serious alternative to traditional fossil fuels.

"When you open an orange, what you're smelling is limonene – it's a hydrocarbon that has excellent jet-fuel properties and recently outperformed traditional jet fuel in a model aircraft," says Tim, the Queensland winner of FameLab Australia 2014.

"We can take genes from oranges or lemons and assemble them in yeast to turn them into tiny limonene factories, which eat sugar and spit out orange-flavoured jet fuels," he says. But too much limonene is toxic to yeast cells, so Tim and his colleagues have worked out how to help the yeast survive the toxic conditions to produce greater volumes of the fuel.

They've redesigned the bioreactor so the fuel is removed immediately after being produced by the yeast. This has allowed the same yeast to tolerate up to 700 times more fuel than it would in a traditional bioreactor. And they're also altering the genes of the yeast to help it withstand higher levels of limonene.

Tim has just completed his PhD with AIBN and is part of a team working with Boeing and Virgin to come up with an alternative to petroleum-based fuels.

STUDYING BEES TO LEARN ABOUT DECISION-MAKING

Dr James Makinson evicts bees from their homes for a good reason – to figure out how they collectively decide on the next place to live.

James and his colleagues at the University of Sydney, in partnership with two universities in Thailand, have found that not all honeybee species think like the common Western hive bee when it comes to deciding on a place to nest.

It's work that could help with understanding and managing honeybees for pollination services, ecological health, and pest control.

Western hive bees rely on scout bees to search for and 'recommend' – via a distinctive aerial 'dance' – a specific nest location. The process is often repeated after the first 40-minute foray before the swarm is convinced.

Two little-known species – the giant Asian honeybee and the tiny red dwarf honeybee – use a collective decision-making process that enables them to choose a new home quickly. But they aren't as fussy when it comes to the quality of their new home.

From these observations, the team has developed computer models to help make sense of honeybee communication, which James says



JAMES MAKINSON

could also help inform new technologies in other areas.

"Hopefully, in the near future, bee-inspired algorithms will be helping humanity solve complex problems and deal with big datasets."

James was winner of the 2014 NSW state final of FameLab.

GYM HELPS PROSTATE CANCER SURVIVORS' SEX LIVES

Perth researchers have shown that twice-weekly exercise can improve sexual function in prostate cancer patients by 50 per cent.

Now, they're calling on Perth men to participate in a new study to find out why exercise works, and how effective it can be on a broader range of patients.

One in six Australian men will be diagnosed with prostate cancer, and 90 per cent of them will report some form of sexual dysfunction during or after their treatment.

"Men think about sex a lot – on average, every 45 minutes, which is more often than they think about food or sleep," says Dr Prue Cormie, a senior research fellow at Edith Cowan University. "So it's not surprising that sexual dysfunction is the most frequently identified issue of importance among prostate cancer survivors."

Last year, Prue and her colleagues at the Edith Cowan University Health and Wellness Institute put a group of men with prostate cancer through a supervised exercise program involving twice-weekly group-based sessions of resistance exercise, such as weight lifting, and aerobic exercises including walking and cycling.

"After three months, the men involved in the exercise program had a 50 per cent greater level of sexual activity, which was largely driven by an increase in sexual desire," Prue says. "We observed significant improvements such as gains in muscle mass, as well as improvements in fatigue, depression, anxiety, strength, fitness and quality of life that we believe contributed to enhancing men's libido."

Prue was the winner of the WA competition of the 2014 Australian FameLab competition.



PRUE CORMIE

By David Cook and Peter Roberts

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We can improve food safety and quality with irradiation

Australia has the capability and experience to utilise the advantages of phytosanitary treatment using irradiation. Its use should be expanded to domestic production and exports.

Fruit fly is endemic in the Northern Territory, Queensland, NSW and Western Australia. In South Australia the only area where active protection from fruit fly infestation occurs is in the Riverland Fruit Fly Exclusion Zone; while in Victoria only the Greater Sunraysia Pest Free Area and the Yarra Valley Pest Free Places of Production are protected. Tasmania is the only state with fruit-fly-free status.

Horticultural production (essentially fruit and vegetables) outside these protection zones is significantly affected and must be treated to effectively kill or sterilise the fly before it can be sold domestically or exported.

WA is infected with the Mediterranean fruit fly, which is a different species to the Queensland fruit fly, and hence movement between WA and Queensland cannot occur without appropriate treatment. Failure to effectively treat fruit and vegetables particularly for export can result in the loss of market access (and significant financial loss) as occurred with the export of blueberries to Japan in 2010 – and access to this market has not been regained.

Attempts have been made to control fruit fly infestation using a 'sterile insect technique' (SIT). This requires the sterilisation of a large number of male flies, which are released and mate, producing infertile eggs. SIT was successfully introduced into WA in 1991 to eradicate Queensland fruit fly and has been used in SA to eradicate

eight outbreaks in protected zones.

Maintenance of a fruit-fly-free zone requires effective quarantine barriers and, given the difficulties, this generally means that the prospect of reinvasion is relatively high.

Before 2011 treatment was effected by dipping in troughs containing either fenthion or dimethoate, both of which are organophosphates. The neurological toxicity of organophosphates is well-documented and the use of both fenthion and dimethoate was suspended by the Australian Pesticides and Veterinary Medicines Authority by 2012.

As a consequence growers are now required to use one of the following alternatives:

- Methyl bromide;
- Cold storage (generally at 2°C for 14 to 16 days, but both time and temperature depend on the commodity and importing country);
- Pre-harvest chemicals such as trichlorfon (also an organophosphate).

Methyl bromide is commonly used at present. It is an ozone-depleting substance but its use as a quarantine treatment is currently exempt from the 1987 Montreal Protocol on Ozone Depleting Substances and is permitted until "equivalent and economically effective treatments" are developed. The hazards that methyl bromide exposure can present to human health are minimised due to the low concentrations permitted but strict use protocols are required of

fumigators by Commonwealth, state and local authorities to manage the potential risk of inhalation during treatment.

Nevertheless, methyl bromide can penetrate the skin of the treated produce and it is likely that some residue remains. Also, methyl bromide impacts quality and reduces shelf life as heating accompanies the fumigation process. Most fruit and vegetables imported into Australia (grapes, cherries, peaches and asparagus – to name a few) are fumigated with methyl bromide. All fruit and vegetables shipped to Tasmania from the mainland are currently treated with methyl bromide (including lettuce).

For cold storage the temperature and time of storage are strictly enforced as the morbidity of fruit fly can be negated for temperatures above 2°C and any deviation from this can result in the commodity being rejected and dumped. Also, the length of time for treatment has significant impact on shelf life in some cases – grapes for example – limiting it to less than five days.

The irradiation of food for phytosanitary treatment is a technology that has been extensively studied. It has been approved by the US Food and Drug Administration for more than 30 years. In Australia the food standards body, FSANZ, approved its use as a phytosanitary treatment for tropical fruits in 2004, which includes mangos and lychees. Research has shown that an irradiation dose of 150 Gy is sufficient to sterilize fruit fly, but 300Gy is required for mangoes because of the prevalence of seed weevils as well as fruit fly.

Today, persimmons, tomatoes and capsicums have been added to the list and in May the Queensland Department of Agriculture, Fisheries and Forestry (QDAFF) lodged an application with FSANZ for approval for the phytosanitary

Phytosanitary treatment describes the measures taken to control plant diseases, especially in agricultural crops. The Agreement on the Application of Sanitary and Phytosanitary Measures, also known as the SPS Agreement, is an international treaty of the World Trade Organization.

Radiation doses are measured in **Grays (Gy)**, a unit named after the English physicist and radiologist Louis Harold Gray. A Gray is the dose of energy absorbed by a homogeneously distributed material with a mass of 1 kilogram when exposed to ionising radiation bearing 1 joule of energy (1 Gy = 1 J/kg).

irradiation of pome fruit, table grapes, stone fruit, apples, zucchini, melons and berries. In its application, QDAFF pointed out the issue of consumer concern regarding the use of chemical treatments and that phytosanitary irradiation was an effective option to maintain market access. In 2012-13 the forecast value of fruit and vegetables in Queensland was \$2.45 billion, with approximately 70 per cent sold outside the state.

In 2011 COAG approved the interstate transport of irradiated fruit and vegetables. Export protocols have been established with those responsible for biosecurity in New Zealand. These have been in place since 2004 for tropical fruits and were expanded in 2013 to include tomatoes and capsicums. For the 2013-14 tropical fruit season approximately 1000 tonnes of mangoes were exported to New Zealand. For the current tomato and capsicum export season it is projected that 1200 tonnes of tomatoes will be exported together with 300 tonnes of capsicums.

FSANZ Review

In February this year FSANZ published a report, Nutritional impact of phytosanitary irradiation of fruit and vegetables (www.foodstandards.gov.au). The report was based on a comprehensive review of more than 30 papers and unpublished studies on the effects of irradiation on a wide range of fruits and vegetables. The FSANZ review focused on vitamin C and carotene as it is known that these are radiation sensitive and fruit and vegetables contribute significantly to the dietary intake of these vitamins.

The conclusion reached by FSANZ was that phytosanitary doses of irradiation (up to 1000 Gy) do not pose a nutritional risk to the Australian and New Zealand populations. It should be noted that this conclusion reinforces earlier conclusions made by the World Health Organization (WHO), the UN Food and Agriculture Organization (FAO) and the European Food Safety Authority. Specifically, the FSANZ review identified the following:

- The data showed large variations in the concentrations of vitamin A and carotene even in the same type of fruit or vegetable. The variations were mainly due to the fruit or vegetable



Appearance and texture of these capsicums – pre-irradiation (top) and post-irradiation (bottom) – are unaffected by phytosanitary irradiation.

variety (cultivar), growing (seasonal) conditions and ripeness. Post-harvest storage conditions and processing also affect vitamin content;

- Phytosanitary doses (up to 1000 Gy) had no effect on carotene concentrations in fruits and vegetables. There was no effect on vitamin C concentrations in the majority of fresh fruits and vegetables;
- In the few cases where a decrease in vitamin C concentration was observed it was generally within the range of natural variations that could be observed. The effect of irradiation was no more detrimental than the effects found from growing, storage or handling conditions and changing cultivar;
- Estimates were made of the overall vitamin C intake and needs of the population and the contribution of each of the fresh fruits and vegetables studied. When any possible losses of vitamin C were compared to these dietary consumption patterns,

it was found that these changes were unlikely to impact on dietary vitamin intake of Australian and New Zealand consumers; and

- The study agreed with earlier studies which established that irradiation does not affect the nutritional quality of carbohydrates in proteins and fats in food, nor does it reduce mineral content. It also found that irradiation had little effect on non-vitamin bioactive compounds in food such as flavonoids (e.g. anthocyanin in cherries) and carotenoids (e.g. lycopene in tomatoes).

Interestingly, FSANZ noted that post-harvest processing of fruit and vegetables had a significant impact on vitamin C – up to 50 per cent lost with baked tomatoes and processed tomato paste and up to 30 per cent with frozen berries.

The future

In Australia the interstate movement of fruit and vegetables is fundamental in supplying these commodities around the

states month-by-month, due to seasonal variations (tomatoes are an example). Due to widespread fruit fly infestation it is mandatory that phytosanitary treatment is required. In addition, the much publicised boom in horticultural exports cannot occur without agreed phytosanitary protocols.

Consumers want fruit and vegetables free of chemical residues. Growers do not favour cold storage because of its impact on shelf life and any treatment that involves heat will affect the quality of the product as well as impact on the nutrient levels.

The FSANZ Report identifies that there is no effect on the nutrient markers in fruit and vegetables irradiated for phytosanitary

purposes at less than 1000Gy. The export of irradiated mangoes and lychees to New Zealand since 2004 has shown to be effective in preventing fruit fly infestation in that country and the confidence that it has engendered in the biosecurity authorities has now been extended to the importation of Queensland-grown tomatoes and capsicums.

Australia has the capability and experience to utilise the advantages of phytosanitary treatment using irradiation.

Given the disadvantages of other forms of treatment it is logical that its use should be expanded to domestic production and for exports.

DR DAVID COOK FTSE was Executive Director of ANSTO 1988–94 and has maintained an interest in food irradiation. He is a consultant to Steritech Pty Ltd, on the use of X-rays for the phytosanitary treatment of fruit and vegetables. He is on the Board of the Academy and a Director of Steritech.

DR PETER ROBERTS has researched and advised on the biological effects and uses of ionising radiation for 40 years. He worked for 30 years as a senior scientist and manager for the nuclear science centre in New Zealand. He is now a consultant with clients that include the International Atomic Agency, New Zealand government departments and Steritech, with food irradiation one of his areas of expertise.



The Fyansford Bridge, a Monier arch bridge over the Moorabool River near Geelong, opened in 1899 and carried Hamilton Highway motor traffic for 70 years. It was awarded an EA heritage marker in 2012.

Historic Monier bridges awarded

Six historic Monier arch bridges in Bendigo, Victoria, in which the use of reinforced concrete was pioneered, have been awarded Engineering Heritage Markers.

"Between 1901 and 1902 eight bridges – of which six still stand and carry traffic – were built in the Bendigo area by the Monash & Anderson engineering company, led by General Sir John Monash, who went on to be a military commander in World War I," says Mr Owen Peake, Chair of Engineers Australia's Victorian Heritage Committee.

"The Monier arch bridge design has since been superseded by bridges of T-shaped concrete beams, but represent an important 'stepping stone' in the development of reinforced concrete bridges. Monier arch bridges took us from masonry and timber bridges to the reinforced concrete bridges we see today.

"At the turn of the century when these bridges were built, Australia was undergoing a transformation into a car-loving nation. These bridges helped Bendigo and the surrounding area evolve into the city we see today," Mr Peake says.

ALL ABOUT CONCRETE

Reinforced concrete was the brainchild of French gardener Joseph Monier, who was not satisfied with clay and wooden flowerpots and began making cement pots and tubs, which he strengthened with embedded iron mesh. He obtained his first patent in 1867, on iron-reinforced troughs for horticulture, and obtained more patents – iron-reinforced cement pipes and basins (1868); iron-reinforced cement panels for building façades (1869); bridges made of iron-reinforced cement (1873); reinforced concrete beams (1878).

In 1875 the first iron-reinforced cement bridge ever built was constructed at the Castle of Chazelet, in France. In 1886 German engineer Gustav Wayss bought Monier's patent and, from the 1890s, patents were taken out on behalf of Wayss in Australia.

Initially, the main products were pipes and arch structures using the Monier system as refined by Wayss and his colleagues. Monier's name was perpetuated in the Monier Pipe Company of Melbourne, and its successor, the Monier Pipe & Reinforced Concrete Construction Company. About 20 Monier arch bridges were built in Victoria.

FUTURE FARM INDUSTRIES CRC CLOSES ITS DOORS

The Future Farm Industries CRC (FFI CRC) has concluded after seven years (2007–14).

The CRC says it leaves a legacy which has positively impacted more than one million hectares (estimated to grow to 3.8 million hectares by 2030) across southern Australia through innovative research and farming system such as EverGraze, EverCrop and Enriched forage.

According to the CRC, perennial plants in Australian farming systems will bring a net benefit of \$1.6 billion dollars to Australian Agriculture by 2030, of which Future Farms Industries CRC has been a major stimulant. The CRC expects to have delivered a total net benefit of more than \$1 billion in commercial and industrial growth by 2030.

FFI CRC CEO Peter Zurzolo said: "The CRC's primary objective had been met, which was to contribute substantially to Australia's growth through the transformation of agricultural production across southern Australia using perennial plant based farming systems."



Associate Professor Michael Higgins, Chief Investigator of the Steel Manufacturing Hub, (front) and Director Oscar Gregory.

UoW Hub tackles steel research

Australia has a new research hub, bringing together the best and brightest scientists and engineers from Australia's steel manufacturers and research institutions, to drive industry innovation and improve global competitiveness.

The ARC Research Hub for Australian Steel Manufacturing, based at the University of Wollongong (UOW), which will tackle R&D programs to address manufacturing techniques and processes, innovation in new products and best-practice pathways, was launched in Canberra in September by Industry Minister Ian Macfarlane.

Supporting partners in the research hub include Arrium, Bisalloy Steels, Cox Architecture, Australian Steel Institute, Lysaght, the University of Queensland, the University of NSW, the University of Newcastle, Swinburne University of Technology and RMIT.

Steel Research Hub Director Mr Oscar Gregory said the steel industry has had to face extremely challenging conditions since the global financial crisis.

"Now that the industry is seeing some improvement, it is timely that the Steel Research Hub brings together the combined skills and expertise of university and Industry researchers to transform the Australian industry into a position of sustainability and global competitiveness," he said.

UOW Deputy Vice-Chancellor (Research) Professor Judy Raper FTSE

said UOW's strong historic links with the steel industry put it in a prime position to drive the national industry.

"The Hub's aim is to strengthen the industry by developing innovative products and processes that will improve its global competitiveness," she said. "So in a sense the Research Hub is extending and refining something we at UOW have been doing for the past 60 years. We all know that working together generally produces far better outcomes than working in isolation, and I commend the Australian Research Council for bringing this group together."

BlueScope's General Manager Manufacturing, Mr John Nowlan, said: "We are excited by the prospect of further improving manufacturing techniques and accelerating the delivery of innovative new steel products to the market. As a world leader in painted and coated steel products, BlueScope is focused on building on this position and believe the hub is a significant step forward in helping to maintain a competitive and sustainable steel industry in Australia."

NEW BIOPROCESSING HUB AT MONASH

Monash University has two new bioprocessing centres, which the illustrate the need for new links between industry and research if Australia is to capitalise on its competitive strengths, according to Industry Minister Ian Macfarlane.

Mr Macfarlane launched the Bioresource Processing Research Institute of Australia (BioPRIA) at Monash University and also opened the ARC Hub for BioProcessing Advanced Manufacturing.

The latter is a three-year \$1.6 million project which – when combined with industry and university contributions – provides a \$3.5 million investment to convert bio-materials into marketable materials, chemicals and energy products like new composites and smart packaging.

"Australia's industries of the future will be based around our areas of competitive strength and will rely on world-leading research and development," Mr Macfarlane said.

"Close collaboration between the forestry and paper industry and this research institute is a great example of the transition needed so Australia can capitalise on higher value-added industries based on research, innovation, and a highly skilled workforce.

"Global growth and product substitution in biobased chemicals is tipped to grow to around 22 per cent of the total market by 2025; representing around \$2.5 billion of a \$10.8 billion Australian market by 2025," Mr Macfarlane said.

The ARC Research Hub, led by Monash, will combine cash and in-kind contributions from industry partner organisations, including Australian Paper, Carter Holt Harvey Australasia, Norske Skog Paper Mills, Orora Paper, Visy Industries and Circa Group.

ARC CEO Professor Aidan Byrne said the Hub would deliver innovative solutions to challenges that face our bioprocessing industries.

"This Research Hub will develop new and practical solutions that will help to transform these industries, which is the purpose of the Industrial Transformation Research Program," he said.

"It will allow a new generation of researchers to operate in an environment that is intrinsically linked with an industry setting.

"This is an invaluable opportunity for our young researchers; it enables them to see the research world from an end-user perspective and engage with experts in industry."



Officially launching the Steel Research Hub Director (from left) Mr Oscar Gregory, ARC CEO Professor Aidan Byrne, UOW Deputy Vice-Chancellor (Research) Professor Judy Raper, Minister for Industry Ian Macfarlane and BlueScope Steel General Manager Manufacturing Mr John Nowlan.

By Ian Rae
iandrae@bigpond.com



One for the technocrats and the petrolheads

Road transport is just one of the key aspects of human activity that needs to evolve from a system that consumes irreplaceable resources and degrades the environment into one that will be both supportable and benign.

So say the authors, who are well credentialled, none more so than local battery expert Dr David Rand FTSE. Their publication is filled with diagrams, statistics and equations: it's a serious textbook with over 300 pages of solid text, 11 pages of index, an 18-page glossary of terms, and eight pages of acronyms, symbols and units.

In all this technocracy the authors never lose sight of the human factors that link us so tightly to our cars, a passion they introduce by way of Kenneth Grahame's Mr Toad (of Toad Hall).

Then the formal text begins, with early vehicles and their rapid evolution causing the construction of roads and developments in engineering and giving us atmospheric pollution of various kinds.

There is comprehensive coverage of the internal combustion engine vehicle, extending beyond the engine itself (spark and diesel) and the use of alternative fuels, to the suspension, braking, exhaust system and other peripherals of the motoring world.

Following this introduction to the basics, a chapter entitled 'Progressive Electrification of Road Vehicles' opens the way for discussion of solar cars, batteries and supercapacitors, hydrogen and fuel cells, and ways of charging

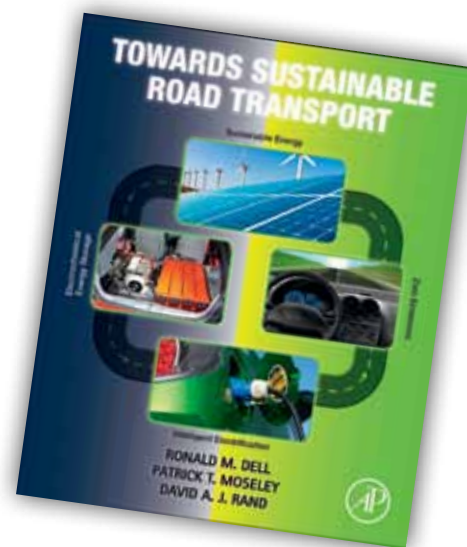
batteries with mains electricity or on-board generation in hybrids.

The coverage of CSIRO's Ultrabattery™, which combines an accumulator with a supercapacitor, explains why the combination takes advantage of the strengths and avoids the limitations of each component. Text boxes help with matters such as octane ratings, pre-ignition and electrochemical cell terminology, and I enjoyed the technical vignettes, such as the rise of and fall of the steamer, alternator vs generator, the introduction of the starter motor, and monocoque construction that obviated the chassis.

I'm sure they will appeal to petrolheads everywhere, as will the many well-chosen photographs of cars and engines.

Addressing 'The Shape of Things to Come', the authors see that the internal combustion engine will be with us for several decades yet and that the lead-acid battery will be hard to beat despite all the research that has gone into other types. We can expect to use more biofuels and this, along with several other factors, will contribute to lowering of vehicle carbon dioxide emissions.

Despite this, however, the growth in the car fleet, especially in China and India, will push emissions 35 per cent above current levels by 2050. There will be progressive electrification of the drive train, but fuel cell vehicles "pose major infrastructure issues and may not play a significant role on the world stage before 2050", except for buses operating from central depots.



Towards Sustainable Road Transport by Ronald M. Dell, Patrick T. Moseley and David A.J. Rand (Academic Press/Elsevier, Amsterdam, 2014; xxvii + 345pp, €48.71)

Turning again to the social dimensions, there is interesting discussion of the possible impact of driverless cars and of governments using 'carrots' and 'sticks' to lure or push us into the future.

Carrots could include tax breaks and preferential parking for those who purchase eco-friendly vehicles, while sticks (some already in operation) could include whole-of-fleet caps on vehicle emissions.

The authors warn, however, against too great an interference in the market lest there be unexpected consequences. As with vehicles, starting and stopping are critical events for sticks and carrots.

We can all learn a lot from this book. It takes us from the technologies of the recent past, through present practice, and into a reasonably foreseeable future.

You can skip the highly technical bits, if it all gets too much, and still improve your knowledge of something you thought you knew all about – your car.

BREAKTHROUGH ON HYDROGEN

Australian and Taiwanese scientists have discovered a new molecule which puts the science community one step closer to solving one of the barriers to development of cleaner, greener hydrogen fuel cells as a viable power source for cars.

Scientists say that the newly discovered '28copper15hydride' puts the world on a path to better understanding hydrogen. Potentially, even how to get it in and out of a fuel system, and to store it in a manner which is stable and safe – overcoming Hindenburg-type risks.

The molecule was synthesised by a team led by Professor Chenwei Liu, from the National Dong Hwa University in Taiwan, who developed a partial structure model. The chemical structure determination was completed by the team at ANSTO, using its KOALA, one of the world's leading crystallography tools.

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.

Leanna Read is new SA Chief Scientist



Dr Leanna Read FTSE is the new South Australian Chief Scientist, replacing another Fellow, Professor Don Bursill AM FTSE, who has completed his three-year term.

A biotech expert and Academy Director, Dr Read is SA's first female Chief Scientist.

Dr Read was appointed to the ATSE Board in January 2013. Her appointments include Chair of the CRC for Cell Therapy Manufacturing, non-executive director of Biosensis Pty Ltd, and member of the Commercialisation Australia Board, the SA Economic Development Board, the SA Premier's Science and Industry Council, the University of South Australia Council and the 'angel investor' network BioAngels.

Dr Read has led a number of research and commercial ventures including the CRC for Tissue Growth and Repair. In 2001 she founded the SA biotechnology company TGR BioSciences Pty Ltd and served as the company's Managing Director and CEO until 2012. She also served on PMSEIC, as well as the Federal IR&D Board for six years.

Announcing Dr Read's appointment, SA Science Minister Gail Gago said: "This renowned biotechnology expert also brings a wealth of executive, board and investment experience in technology-based businesses. As the fourth Chief Scientist for South Australia and the first woman to hold the position, Dr Read will help strengthen connections between industry and researchers, commercialise our research and position our state as a leader in STEM education and innovation."

Ms Gago thanked Professor Bursill for his leadership and guidance in science and innovation.

"Professor Bursill's advice to the State Government has been a key contributor to raising the research and innovation profile of SA and enhancing opportunities for international engagements with Germany, Italy and China.

"He has championed the link between science and industry, and has developed initiatives to promote the importance of the STEM disciplines," Ms Gago said.

"His passion bolstered the Premier's Research and Industry Fund, which has attracted significant investment into the state and formed new partnerships between researchers and industry. Professor Bursill has helped the Government underscore the fundamental role that science plays in advancing our economy and solving emerging challenges. His legacy will see SA reap the benefits from science investments for generations to come," Ms Gago said.

Dr Read welcomed the opportunity to promote and enhance SA's research capabilities during her three-year term.

"This is a critical time for the SA economy. The uptake of science innovations by industry will be a key factor in our future prosperity. I am very much looking forward to working with our researchers, industry groups, government and the wider community," Dr Read said.

CATHY FOLEY WINS IEE AWARD

Dr Cathy Foley PSM FTSE has been named to receive an IEEE Council on Superconductivity Award, for continuing and significant contributions to the field of applied superconductivity (small-scale applications).

The Award was presented at the Applied Superconductivity Conference in Charlotte, North Carolina, in August.

Dr Foley, Chief of CSIRO Materials Science and Engineering, was honoured for "continuing and significant contributions in the field of superconductor electronic applications", particularly for:

- the development of a novel form of YBCO, grain boundary Josephson junction and its incorporation into sensitive HTS SQUID magnetometer systems;
- the development and commercialisation of the LANDTEM geophysical survey system that has located mineral deposits worth more than US\$6 billion; and
- her service to the applied superconductivity community through service on numerous committees and boards, including those promoting the recruiting and mentoring of women in science and engineering.

IEEE, the Institute of Electrical and Electronics Engineers, is based in the US and bills itself as the world's largest professional association for the advancement of technology, with more than 400,000 members.

Cathy Foley



ATSE IN FOCUS

Two Fellows win ARC Laureate Fellowships



Veena Sahajwalla



Rose Amal

Technologies to transform carbon dioxide into sustainable fuels and end-of-life e-waste into high-value materials have won University of NSW Scientia Professors Rose Amal FTSE and Veena Sahajwalla FTSE Australian Laureate Fellowships.

They won two of 16 Australian Research Council Fellowships announced in August by the Education Minister, Christopher Pyne.

Professor Sahajwalla, director of UNSW's Centre for Sustainable Materials Research and Technology, was awarded \$2.37 million for research into microrecycling of e-waste.

She also received a Georgina Sweet Fellowship, which will enable her to undertake an ambassadorial role to promote women in research. She described the awards as a "huge honour and privilege".

Earlier this year, Professor Sahajwalla's centre was awarded \$2.2 million by the Federal Government to create a 'green manufacturing' research hub at UNSW.

Professor Amal, leader of the UNSW School of Chemical Engineering's Particle and Catalysis Group, was awarded \$2.38 million to develop technology to transform CO₂ into sustainable fuels, a process that could revolutionise the recycling of the greenhouse gas.

Professor Amal, the former director of the ARC Centre of Excellence for Functional Nanomaterials, is recognised as a pioneer and leading authority in the fields of fine particle technology, photocatalysis and functional nanomaterials.

She has won many awards, including being named in the top 100 most influential engineers by Engineers Australia.

UNSW Deputy Vice-Chancellor (Research) Professor Les Field said: "This is transformative research of the highest quality that has the potential to have a major impact on society. The university congratulates Scientia Professors Rose Amal and Veena Sahajwalla on the recognition of their outstanding work."

ALAN ROBSON GOES TO WA HALL OF FAME

Emeritus Professor Alan Robson AO FTSE has been named by the WA Premier, Mr Colin Barnett, as the 2014 Inductee into the Western Australian Science Hall of Fame.

As one of Australia's leading science education figures, Professor Robson has held many distinguished positions including Vice-Chancellor of The University of Western Australia.

Professor Robson was Chair of the Group of Eight (2007–10), Deputy Chair of the Council of the National Library (1998–2005), Deputy Chair of Universities Australia (2009–11), and a member of the WA Science Council (2003–09) and the CSIRO Board (2003–08).

He was Foundation Chair of the Grain Legumes Research Council, Deputy Chair of the ARC Research Grants Committee and a member of the Committee for University Training and Staff Development (1998–99), the Australian Teaching and Learning Committee (2000–04) and the Board of Directors of the Australian Universities Quality Agency.

In 2001 Professor Robson chaired the Ministerial Taskforce on Structures, Services and Resources Supporting Government Schools.

An agricultural scientist, his early research on the mineral nutrition of plants and soil fertility contributed to the prosperity of farming communities and the continued success of WA's grains industry. He counts his impact on graduate students and their subsequent contributions to science and



Alan Robson

agriculture among his greatest achievements.

He joins other distinguished Academy Fellows in the WA Science Hall of Fame – Professor Lyn Beasley AO FTSE, former WA Chief Scientist (2013), Professor Stephen Hopper AC FTSE (2012) and Dr Bernard Bowen AM FTSE (2011).

Professor Robson was chair of the WA Organising Committee for the 2014 ATSE Clunies Ross Awards.

FELLOWS ARE LONG-TIME AUSIMM STALWARTS

Three ATSE Fellows have been named by the Australasian Institute of Mining and Metallurgy (AusIMM) as among its longest-serving members from a total membership of 13,500.

Mr Keith Alder AM FTSE heads the Fellows, with 70 years of membership of AusIMM celebrated this year.

Mr John Innes FTSE has achieved 60 years' membership and Mr Ken Dredge FTSE has achieved 50 years' membership.

Mr Alder, from Sydney, joined the Academy in 1977. He is a former Director of Research and Commissioner at the Australian Atomic Energy Commission, having earlier headed its Metallurgy Section.

Mr Innes, of Melbourne, a Fellow since 1989, spent most of his career in the resources industry, serving in senior roles with Hamersley Iron and CRA before serving as a director of a number of resources companies.

Mr Dredge, who lives in Brisbane, joined the Academy in 1990. He is a former Managing Director of Dominion Mining Ltd and Chair of Tarong Energy and is widely known in the Australian energy generation scene.

A number of Fellows are also AusIMM members and some have served in leadership roles in the organisation.



Ken Dredge



John Innes

Tanya Monro joins UniSA



Tanya Monro

One of Australia's most decorated scientists, Academy Vice-President and former SA Australian of the Year, Professor Tanya Monro FAA FTSE, has been appointed Deputy Vice-Chancellor Research and Innovation at the University of South Australia.

Professor Monro will join UniSA in November, leaving her current roles as Director of the ARC Centre of Excellence in Nanoscale BioPhotonics and of the Institute for Photonics and Advanced Sensing at the University of Adelaide.

She holds an ARC Georgina Sweet Laureate Fellowship and is the author of more than 500 journal and research articles.

Announcing Professor Monro's appointment, Vice-Chancellor Professor David Lloyd said he was delighted to welcome a scientist and leader of her standing to UniSA.

"Tanya is one of Australia's most highly recognised scientists and a model of the drive and vigour that characterises the next generation of Australian research," he said.

"The quality of her work is internationally recognised and her proven capacity to work with industry and to form partnerships and collaborations to bring forward new knowledge and solutions will be an asset to our institution as we build Australia's university of enterprise."

Professor Monro earned her PhD in physics in 1998 from The University of Sydney, for which she was awarded the Bragg Gold Medal for the best Physics PhD in Australia.

In 2000, she received a Royal Society University Research Fellowship at the Optoelectronics Research Centre at the University of Southampton before returning to Australia almost 10 years ago.

She is a member of the SA Premier's Science and Industry Council, a former SA Scientist of the Year, and winner of the Telstra Business Women of the Year Award.

In 2012 Professor Monro won the Pawsey Medal for outstanding research in physics by a researcher under the age of 40 for her work in optical physics, which has led to the development of new forms of optical fibres for use in telecommunications, biology, health, food and wine production, environmental monitoring and the defence industry.

Professor Monro is extremely active at the interface between private industry and academic research and has commercialised output from her own research area through a spin-out company. Additionally she is a member of the SA Economic Development Board and chairs its Science, Innovation and Commercialisation subcommittee.

Professor Monro has also been named Chair of the National Youth Science Forum,

having been an alumna of its predecessor, the National Science Summer School, in 1990.

She said that outreach programs such as the Forum, which is more than 30 years old, played a critical role in supporting some of the brightest young people from around Australia by immersing them in stimulating science.

SINGLETON SIGNS OFF AFTER 40 YEARS

Former Arup Partnerships Chair and Arup Group Director Mr David Singleton FTSE has retired from Arup after more than 40 years with the firm.

David will continue in his role as Chairman of the Infrastructure Sustainability Council of Australia and with his non-executive-director roles on Boards including Standards Australia and Swinburne University.

Since 1973 he has worn numerous 'hats' at global consulting firm Arup, including serving as CEO from 1999–2004 and as Chairman of Global Infrastructure from 2004–11. He was also the Main Board director, Arup Group Ltd, for 10 years; Chairman, Director and Council Member for The Arup Partnerships, for 16 years, with seven years as Chair; and Global Planning, Group Sustainability and Group Diversity leader.

He spearheaded business growth and global strategy development on diversity and sustainability over the past decade.

Chairman of Arup in Australia, Peter Bailey, said Mr Singleton had been, and would continue to be, a leading figure in the industry.

"David has a special interest in drawing the engineering profession together to forge closer links with other influential groups such as policy makers, politicians, academia and scientists," Mr Bailey said.

"Throughout his career, David has demonstrated the positive and tangible impact engineers can have on our communities ... and he is viewed as an authority in the field of engineering, and as a respected and trusted senior member of the profession."



David Singleton

ATSE IN FOCUS

Ian Ritchie showed the way in WA

Emeritus Professor Ian Ritchie AO FAA FTSE, who was honoured in the 2014 Queen's Birthday Honours, was renowned for his leadership in chemistry and hydrometallurgy and his strong contributions to his adopted state, WA.

Professor Ritchie was honoured for "distinguished service to science in the field of chemistry and hydrometallurgy, as an academic and educator, and for fostering technical innovation in business and industry".

He was a Foundation Member, WA Premier's Science Council (2001); Member, Joint Minerals Council Tertiary Education Taskforce and AVCC Committee (1998–99); and a Member of the WA Minerals and Petroleum Education Research Institute Working Group (1997).

Professor Ritchie was the foundation CEO of the Parker Centre (the Parker CRC for Integrated Hydrometallurgy Solutions) from July 1992 when it first opened for business until January 2001. He was the driving force behind the centre's creation.

He graduated from Cambridge University, and obtained his PhD at Melbourne University, subsequently lecturing there and also at UWA and Murdoch University, where he held the Chair of Chemistry from 1984–2002.

Professor Ritchie, remembered by his WA colleagues as "a wise, witty and considerate person", made many novel discoveries in chemistry spanning an unusually wide range of research areas.

Born in Tidworth, England, in 1936, Professor Ritchie settled in Australia in 1962, aged 26, and made Perth his home in 1972.

He worked in the US as an R&D engineer (1959–62), and then in a number of roles at Melbourne University (Senior Lecturer, 1968–72), before moving to UWA as Associate Professor, Department of Physical and Inorganic Chemistry (1972–83).

He served as Professor of Chemistry at Murdoch University (1984–92), including a year as Pro-Vice-Chancellor (Research), before becoming Director of the Parker Centre.

Professor Ritchie was a Fellow of the Royal Australian Chemical Institute and of the Australian Institute of Mining and Metallurgy and was a member of the Scientific Advisory Committee (1975–80) to the WA Clean Air



Ian Ritchie

Council, a predecessor of the WA Environmental Protection Authority.

In delivering a eulogy to Professor Ritchie, his long-time friend Dr Greg Power noted that he had made an enormous contribution to academia, science, the environment and the community.

"Perhaps Ian's greatest gift was a natural instinct for leadership, which was evident from the outset in the success of his research groups, and which blossomed as his broader influence grew," Dr Power said.

"Ian was always a collaborator, seeking to engage rather than to dominate."

Referencing the formation of the Parker Centre as a world centre for hydrometallurgy, Dr Power said "Ian picked up the baton with furious determination and, by dint of masterful negotiation, creative adaption and just sheer hard, hard work, brought the dream to fruition".

"With Ian at its helm, the Parker Centre rapidly grew to become an acknowledged world leading institute in its field. Its breadth of collaboration, research output and education program were second to none by the time Ian stepped down after a decade at the helm – probably the most intense and productive decade of his frantically busy career.

"The Parker Centre was arguably the most successful of all of the centres spawned by the Federal CRC program. Its rapid growth and spectacular success was a tribute to Ian's leadership and vision, informed and fuelled

by his intimate knowledge and passionate interest in the research core of the centre and the education and wellbeing of its people. And he made it an interesting and fun place to be.

"He could never abide laziness, foolishness or dishonesty – an idle or devious student (or colleague for that matter!) could expect from time to time to be flayed with a bout of scathing wit. None of us is perfect.

"But beneath there was always a heart of gold, a soft humanity, a real humility, and a deep commitment to service and truth."

TONY GREGSON JOINS CIAR

Dr Tony Gregson AM FTSE is one of five new members of the Commission for International Agricultural Research, which provides expert, strategic advice on priorities for the Australian Centre for International Agricultural Research (ACIAR).

ACIAR plays a critical role in the Australian Government's new aid policy by encouraging Australian agricultural scientists to use their skills for the benefit of developing countries as well as Australia.

Dr Gregson, a Fellow since 2003, a member of the Academy's Audit Committee and a Director of the Crawford Fund, is a grain grower from Victoria's Wimmera region with an extensive science and corporate research management background.

He currently chairs Plant Health Australia and formerly chaired the Board of Trustees for Bioversity International. He is an Adjunct Professor in Environmental Management at the University of Ballarat, Chairman of the University of the Melbourne's School of Botany Foundation and a director of Rural Industries Skills Training.

He is a former chair of two CRCs, a former inaugural member of the CSIRO and Grains Research and Development Corporation boards, and a former member of the International Maize and Wheat Improvement Center (CIMMYT), ANSTO and Rural Finance Corporation of Victoria boards.



Tony Gregson

ATSE IN FOCUS

Glen Wightwick moves to UTS

Professor Glenn Wightwick FTSE has been named Deputy Vice-Chancellor, Research at the University of Technology, Sydney (UTS), succeeding Professor Attila Brungs, who has been appointed UTS Vice-Chancellor.

Professor Wightwick won the job against tough national and international competition and will join UTS from IBM, where he is currently Director, IBM Research – Australia and IBM Australia Chief Technologist.

He brings global experience from his role at IBM, having led teams in the US and China, worked on IBM's global technical strategy and established world-leading research laboratories here in Australia.



Glenn Wightwick

Professor Vicki Sara FAA FTSE, UTS Chancellor, attributed the number and quality of the candidates to the university's rapidly growing research reputation and ambition.

"Glenn's passion, commitment to innovation, research excellence and reputation as a leading technologist set him apart from the other candidates," Professor Sara said, noting he was recognised as a leader in developing Australia's ICT industrial R&D base and a significant contributor to innovation across the nation.

"Glenn combines significant industry experience with research excellence. He

has a distinguished research track record in terms of publications, but also patents and commercialisation.

"Glenn has also served on the ARC College of Experts, is a Fellow of the Australian Academy of Technological Sciences and Engineering and has led national bodies and committees such as the NSW Digital Economy Industry Taskforce."

"Glenn has been the driving force behind building our IBM Research capabilities in Australia," said Mr Andrew Stevens, Managing Director, IBM Australia and New Zealand. "He was instrumental in the establishment of our laboratory to create innovative solutions that solve industry challenges across healthcare and life sciences, natural resources management and natural disaster management.

"I'm thrilled that Glenn will continue his work in research here in Australia through this new appointment and wish him every success," Mr Stevens said.

AMERICAN MEDAL FOR MILTON HEARN

Professor Milton Hearn FTSE has been awarded the 2015 American Chemical Society Award in Chromatography, in recognition of his outstanding contributions internationally in the fields of chromatography and separation sciences.

Professor Hearn is Associate Director of Green Chemical Futures–Industry and Director of the Victorian Centre for Sustainable Chemical Manufacturing at Monash University.

His research has resulted in the discovery of a range of novel technologies, new methods and breakthrough concepts that have ultimately led to improvements in the quality of human life.

He has previously received the Leighton Memorial Medal, the Green Chemistry Challenge Medal, the R.K. Murphy Medal, the Analytical Chemistry Medal, the Applied Research Medal and the H.G. Smith Medal, all from the Royal Australian Chemical Institute, as well as a Centennial Medal of the Commonwealth of Australia, an



Milton Hearn

Alexander von Humboldt Forschungspreis and numerous other national and international medals and awards.

Professor Hearn has authored more than 600 original scientific papers and has made many other contributions to the chemical and biotechnology industry and the public within Australia and overseas.

He will receive the award at the Society's National Meeting in Denver, Colorado, in March 2015.

Professor Hearn said: "I am thrilled that the research my team and I have carried out has been recognised for its global and environmental impact by the American Chemical Society. The chromatographic sciences represent an enabling field of knowledge, which underpins most other areas of scientific, biomedical and biotechnological research, development and product manufacture."

MARTIN COLE GOES TO PRINT AGAIN

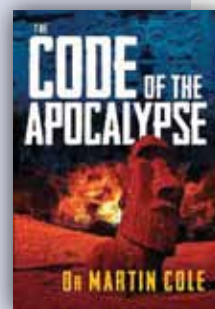
The second book in 'The Code' sci-fi trilogy from Fellow and author Dr Martin Cole FTSE was launched at the Melbourne Writers Festival in August.

The Code of the Apocalypse is promoted as "an engrossing adventure thriller inspired by scientific and historical facts" in which readers "join an epic adventure to exotic places to learn the secret of the ancient prophecy hidden within Mayan hieroglyphic inscriptions".

It follows Dr Cole's earlier book *The Code of the Pharaoh*. Both are published by Sid Harta Publishers and available (\$24.95) from imRAC-books or Martin Cole.

Dr Cole bases his fiction work on historical and scientific facts, drawing inspiration from his creative career as an inventor and entrepreneur, eight years on PMSEIC and two terms as National President of Engineers Australia.

He is known for his work on the design of electronic products, systems and software for the prevention of crime and fire, and he is best known for pioneering the aspired smoke detection industry.



ATSE IN FOCUS

Graeme Russell a leader in rubber engineering



Graeme Russell

Dr Graeme Russell FTSE was widely known for his pioneering work in engineering research in the rubber industry, which built on his PhD in mechanical engineering at the University of Queensland (UQ) in 1969.

After working in the sugar industry as a researcher with CSR and UQ, he became Technical Manager and then Technical Director of the Queensland Rubber Company Pty Ltd.

His 2001 citation said Dr Russell "gained distinction through his inspiring leadership, creativity and innovative technological and engineering research in the rubber industry" and for the "quality of the products developed and their technological, economic and environmental significance" both nationally and internationally.

He was a distinguished scientist and engineer who developed industrial rubber products utilising specific rubber compounds and manufacturing methods.

"His demonstrated skill and versatility have led to major advances in the applicability of rubber to a range of products," it said, and was "recognised as Australia's leading expert in the application of elastomeric products" in engineering – including in port facilities, rail track, dam and bridge components and the explosives industry.

These included development of high-energy-absorbing marine fender systems for wharfs, acoustic isolation bearings for buildings and railways, inflatable rubber dams and specialised sealing systems for varied uses, including detonators and dry docks.

His pioneering work in wharf fender

systems led to the establishment of the Fentek brand, which achieved worldwide sales of complete fender systems, earning significant export income.

"His achievements are supported by world patents, scientific papers, licensing agreements and the installation of his product designs in more than 45 countries."

He was a Fellow of the Institution of Engineers, a member of the Australian Plastics and Rubber Institute and provided professional support to UQ, Queensland University of Technology and James Cook University.

Dr Russell died in Brisbane in July, aged 77.

AAS HONOURS GUS NOSSAL

The Australian Academy of Science has announced two new national awards named after pre-eminent Australian scientists, Academy Fellows Professors Gus Nossal AC CBE FRS FAA FTSE and Jacques Miller.

The Gustav Nossal Medal for Global Health and Jacques Miller Medal for Experimental Biomedicine will be awarded to early- and mid-career Australian researchers.

AAS President Professor Andrew Holmes AM FRS FAA FTSE said: "It is fantastic to be able to honour the tremendous contributions of two living legends in Australian science with these new awards.

"Gus Nossal, a former AAS president, has made outstanding contributions to vaccine research and public health, particularly in the developing world," Professor Holmes said.

"Jacques Miller's contributions to medicine have also been highly significant and led to his election to the AAS. He discovered

the function of the thymus, an organ we now know is a fundamental part of the immune system.

"I hope these new medals will encourage our up-and-coming researchers in the fields of public health and biomedical sciences to aspire



Gus Nossal

to similar heights of scientific endeavour."

The awards are open to experimental researchers up to 15 years post-PhD.

Both honorific awards were made possible by the generous donation of Sir Marc Feldmann, a prominent Australian immunologist based at the University of Oxford.

UNIVERSITIES MUST ENRICH THEIR COMMUNITIES: LEE

Regional universities have a fundamental mission to enrich their communities through the excellence of their graduates and the quality of their teaching and research, according to the Chair of the Regional Universities Network (RUN), Professor Peter Lee FTSE.

In a keynote address to the Engagement Australia conference in Wagga Wagga, Professor Lee, Vice-Chancellor of Southern Cross University, said these requirements underscored their role for public good, which must be remembered in the context of the current debate about university deregulation, diversity and funding.

"The Government's proposed reduction in its contribution to student fees could be interpreted to mean that it is no longer prepared to support base capabilities in research – if so, this is a worrying development.

"The emphasis on research and teaching is one of the distinctive characteristics of the Australian university. The impact of research undertaken by regional universities on our regions is significant. Researchers grounded in place approach their research with a specific local perspective very difficult to achieve by others from outside.

"We are deeply committed to our respective regional communities and regional students. We must deliver our core academic endeavours, including research, through engagement," Professor Lee said.

Engagement Australia is the peak body for university–community engagement in Australia.



Peter Lee

ATSE IN FOCUS

Mary O'Kane wins Pearcey Medal

NSW Chief Scientist and Engineer, Professor Mary O'Kane FTSE, has been awarded the 2014 Pearcey Medal.

A senior figure for many years in research policy and higher education in Australia, she

was a pioneer in the field of automatic speech recognition.

She has held senior academic and management positions in several Australian universities including Dean of the Faculty of Information Sciences and Engineering at

Mary O'Kane

the University of Canberra (1989–93), Deputy Vice-Chancellor (Research) and Professor of Electrical and Electronic Engineering at the University of Adelaide (1994–96) and Vice-Chancellor of the University of Adelaide (1996–2001).

At the time of her appointment as VC of the University of Adelaide, Professor O'Kane was the first woman to be appointed to the post in the university's 125-year history and one of the youngest VCs appointed to an Australian university. She was also the inaugural chair of the Group of Eight universities.

Since then, she has been a member of a number of high-level committees, including the ARC and the panel for the Federal Government's Review of the National Innovation System.

Professor O'Kane is Chair of the CRC for Spatial Information and a member of the Board of NICTA.

She has chaired major reviews of the Australian Bureau of Meteorology and the CRC Program, and was Chair of the Australian Centre for Renewable Energy (2010–12). She was formerly a member of the ARC, the CRC

Committee and the boards of FH Faulding & Co Ltd and CSIRO.

The Pearcey Medal is Australia's most prestigious national annual award made to an individual in the Australian ICT industry. It provides recognition to someone who has demonstrated a distinguished lifetime of achievement and contribution to the development and growth of the ICT professions, research and industry.

CHRIS MALLETT JOINS NEW US FOOD RESEARCH FOUNDATION

Dr Christopher Mallett FTSE, Vice President of Research & Development at Cargill Inc, based in Minneapolis, has been named a member of a 15-strong Board of Directors of the Foundation for Food and Agricultural Research (FFAR).

US Agriculture Secretary Mr Tom Vilsack announced the creation of FFAR, which will leverage public and private resources to increase the scientific and technological research, innovation and partnerships critical to boosting America's agricultural economy.

Authorised by Congress as part of the 2014 Farm Bill, FFAR will operate as a non-profit corporation, seeking and accepting private donations in order to fund research activities that focus on problems of national and international significance. Congress also provided US\$200 million for FFAR, which must be matched by non-Federal funds as the foundation identifies and approves projects.

The research funded by FFAR will address issues including plant and animal health;



Chris Mallett

food safety, nutrition and health; renewable energy, natural resources and environment; agricultural and food security; and agricultural systems and technology.

Dr Mallett, a Fellow since 1998, was named corporate Vice-President of Cargill R&D in January 2005 and leads all R&D resources across Cargill. Prior to joining Cargill, he had an academic career in Austria and Australia. He then joined Unilever, the consumer goods multinational, where he held various leadership positions in R&D in the European edible oils and frozen food business.

From 1994–2001, Dr Mallett served successively as Chief of Division, Executive Vice-President and Deputy CEO of CSIRO. In 2001 he joined the dairy multinational Fonterra in New Zealand as senior vice president of R&D and CTO.

A Manxman, he has also served on many boards and advisory boards in the UK, Australia and New Zealand, most recently as a member of the Board of Renessen, the former joint venture between Cargill and Monsanto to develop added-value crop inputs for animal feeds.

PETER WATSON ON NEW IA BOARD

Former Transfield Managing Director Mr Peter Watson FTSE has been appointed to the new Board of Infrastructure Australia.

He currently chairs Victoria's Regional Rail Link, Asset Co Pty Ltd (a specialist asset management company owned by Industry

Funds Management) and Logicomms (an engineering, project delivery and asset management company), and is a Director of Save the Children Australia.

Mr Watson, a Fellow since 2005, spent 10 years heading Transfield, as CEO then Managing Director, and has extensive experience in the construction industry in power stations, steel mills, newsprint plants, grain terminals, and water and sewerage plants.

He was named as one of Australia's 100 most influential engineers in 2008.



Peter Watson

ATSE IN FOCUS

Simon Foote to head ANU's Curtin School of Medicine



Simon Foote

will also benefit from the research being undertaken by Professor Foote and his team, who will be joining him. Their current work includes trying to discover new malaria drugs and research into the high incidence of kidney disease in indigenous populations.

Professor Foote's research interests are in the genetic control of susceptibility to disease, with particular focus on infectious disease.

Professor Foote said he was honoured to have been appointed as JCSMR's new director.

"I'm really excited about it. I've had a reasonable amount of experience

leading research, encouraging researchers to achieve their utmost, increasing funding ... it's the sort of basic bread-and-butter stuff that you need to be able to do," he said.

"But I also really enjoy the science that's happening at these places and the science at JCSMR is actually brilliant."

Professor Kieran Kirk, Dean of the ANU College of Medicine, Biology and Environment, said Professor Foote was one of Australia's top medical research leaders and an outstanding scientist. "He is an international authority on malaria and the relocation of Simon's research group to JCSMR will consolidate and extend ANU's already very substantial activities in this important area of medical research," he said.

ASHLEY BUSH WINS VICTORIA PRIZE

Professor Ashley Bush FTSE, from the Florey Institute of Neuroscience and Mental Health, has won the 2014 Victoria Prize for Science & Innovation (life sciences).

Professor Bush was honoured for his outstanding body of work on translational neuroscience. This includes new findings on the cause of Alzheimer's disease and the

importance of metal biology in degenerative brain diseases.

Professor Bush's research addresses how the interaction of key proteins and metals in the brain contribute to the development of diseases such as Alzheimer's, Parkinson's and Huntington's.

With neither a modifying treatment for Alzheimer's nor a predictive diagnostic test currently available, this research is urgent. Professor Bush is actively working to develop disease-modifying drugs, as well as blood tests to help diagnose and monitor disease progression.

Degenerative brain disease research is of critical importance given that the proportion of Australians aged over 65 is projected to reach more than 27 per cent of the population by 2051.

Professor Bush's approach has championed an alternative to mainstream research by using an innovative target to develop a class of novel drugs (represented by PBT2) that has shown promise in not only treating

Alzheimer's disease and other brain diseases, but in potentially preventing the progression of age-related cognitive decline.

The mechanism of this class of drug involves restoring the uptake of trapped physiological metals to trigger biochemical and anatomical changes to rescue brain function.

Professor Bush, a Fellow since 2009, is Director of the Oxidation Biology Unit at The Florey Institute, an NHMRC Australia Fellow, Co-Director of Biomarker Discovery for the Australian Imaging Biomarker and Lifestyle Flagship Study of Ageing and Chief Scientific Officer of the CRC for Mental Health; he also holds an academic appointment at Massachusetts General Hospital.

He is the recipient of numerous awards including the Potamkin Prize for Alzheimer's research.



Ashley Bush

Professor Simon Foote FTSE, one of Australia's leading medical researchers, has been appointed to lead the John Curtin School of Medical Research (JCSMR) at the Australian National University.

Professor Foote, who is currently dean of Macquarie University's Australian School of Advanced Medicine, will commence as the new director of JCSMR in October.

ANU Vice-Chancellor Professor Ian Young AO FTSE said Professor Foote was very experienced and he was selected after an international search for the right candidate.

"In the past we've produced two Nobel Prize winners and we were very keen to attract a new director who could both lead the school in the way we would like but who was also, in their own right, an eminent researcher," he said.

Professor Foote has worked at the Whitehead Institute at MIT, as a division head at the Walter and Eliza Hall Institute in Melbourne and as the director of the University of Tasmania's Menzies Research Institute.

In addition to his experience, JCSMR

Graduate Research Training.

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