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Australian Synchrotron

PRODUCT TO MARKET

GETTING AUSTRALIA'S BEST THINKING INTO MARKET-READY PRODUCTS AND SERVICES

Contributors discuss how our research organisations are turning some of the nation's best thinking into products and services for national and international markets

Connectivity / Understanding resilient infrastructure

April 2013 / 1 / David Singleton



+ How can we know if replacement infrastructure will be more resilient than that which it replaces?

If infrastructure is to be truly sustainable, we need a way to understand what resilient infrastructure looks like, and we need a way to compare infrastructure designs and systems to achieve the most resilient outcome. Sustainability ratings tools have the potential to help us do this.

In the wake of recent natural disasters like Hurricane Sandy and the Queensland floods, major infrastructure programmes are planned or are underway in several countries. But without properly understanding resilience, how can we know if this replacement infrastructure will be more resilient than that which it replaces?

Infrastructure investment decisions have long-term consequences, as the assets can shape development for decades – often beyond their lifetime. So decisions on infrastructure should anticipate the long-term environment, needs and constraints under which it will function.

However, our ability to predict the future has been shown to be limited. Climate change is introducing deep uncertainty that makes this even more difficult. The environmental conditions under which infrastructure performs are likely to change radically and its design needs to take this into account.

Sustainability thinking is crucial for making clear the connections between the infrastructure project and the local and wider society, economy, environment and businesses. It is also vital to spotting where these connections could cause serious vulnerabilities that put the entire system at risk. Ensuring that these connections are elastic, adaptable and resilient will benefit society, the economy and the environment.

So how do we understand what constitutes resilient infrastructure? How can we compare designs to see how they would contribute to a resilient system? Is there a role for infrastructure rating systems in improving our understanding?

There are several infrastructure sustainability rating tools available... *Read the rest of David's blog at: www.thoughts.arup.com/post/details/268/understanding-resilient-infrastructure.*

Contributor /
David Singleton



Based in Melbourne, I am a civil engineer and planner with many years experience. Having led Arup's infrastructure activities globally for seven years, I became global planning leader in April 2011. Currently I am also Chairman of the Infrastructure Sustainability Council of Australia (ISCA), a Director of Standards Australia Ltd and a member of the board of the Centre for Engineering Leadership and Management. I also spearhead Arup's global sustainability activities, policy and strategy.

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TURNING RESEARCH DISCOVERIES INTO CLEAN ENERGY ALTERNATIVES

Growing global demand for energy and concern for environmental impacts has made renewable energy an important area of research across the world.

Cleantech start-up company, Brisbane Materials, is doing its part after a serendipitous discovery by then University of Queensland (UQ) PhD student and now company Chief Technology Officer, Dr Michael Harvey, working with his technical co-founder, UQ's Professor Paul Meredith.

Brisbane Materials patented materials and processes that enable the creation of a nano-porous silicon dioxide (SiO_2) film from a liquid precursor at room temperature and atmospheric pressure. When applied to solar photovoltaic panels, these films form an anti-reflective coating which improves the efficiency and cost effectiveness of solar panels of all types.

Brisbane Materials was the very first recipient of a Southern Cross Renewable Energy Fund investment, a significant achievement for the start-up and clear endorsement of university-based Australian renewable energy research.

Brisbane Materials has continued to develop its unique anti-reflection solar energy technology for export to the US, Asia and Europe.

This is just one example of UQ research now delivering benefits with the support of UQ's main commercialisation company, UniQuest.

Established by UQ in 1984, UniQuest is recognised as one of Australia's largest and most successful university commercialisation groups, benchmarking in the top tier of global technology transfer. It has created over 70 companies from an intellectual property portfolio of 1500+ patents, and since 2000 UniQuest and its start-ups have raised more than A\$450 million to take university innovations to market.

The Federal Government's 2012 Excellence in Research for Australia (ERA) exercise confirmed UQ as one of the nation's top three universities. ERA reported that research at UQ is well above world standard in more specialised fields than at any other Australian university: this reflects UQ's leading global role in many areas of discovery. UQ's outstanding critical mass offers researchers significant interdisciplinary capability.

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Photo: Dr Michael Harvey and Professor Paul Meredith

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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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Connecting through collaboration in the national innovation system

Sustainable wealth creation comes from repeatedly exploiting the link between innovation, productivity and competitive advantage.



By Calum Drummond
calum.drummond@csiro.au

The conversion of new inventions (creations) into practice can be extremely beneficial for companies. Innovation has two essential components: generation of an idea or invention, and the conversion of that invention into a business or other useful application.

In very simple terms: innovation = invention + exploitation. Another way to express this – innovation is something new that creates value.

Company innovation can lead to increased productivity and competitive advantage in the marketplace. Enhancing innovation in Australian companies is a national challenge and opportunity.

We are fortunate in Australia that we have a functional innovation ecosystem (albeit generally recognised as sub-optimal and in need of improvement) where – despite external pressures such as the high cost of the Australian dollar and relatively slow productivity growth over the past decade – many organisations still have growth opportunities.

There is sometimes a perception that small- and medium-sized enterprises (SMEs) don't have the means to invest in innovation. The truth is that organisations who want to be innovative have multiple avenues to explore to access assistance in this country.

Enterprise Connect's Researchers in Business (RIB) program is just one example of this, along with access to technology vouchers in some areas, tax incentives, import and export assistance, and innovation funds to name a few. Cooperative Research Centres (CRCs), consortia and Precincts also offer opportunities for companies to come together with R&D organisations to seek out competitive

advantage by improving their current products, processes and/or services or, in select cases, develop new ones.

CSIRO is a service provider and consequently we know we are only effective when we build partnerships – we are successful when our partners are successful. From our perspective, the spirit of collaboration is critical to innovation.

"Creativity is thinking up new things. Innovation is doing new things."

– THEODORE LEVITT, HARVARD UNIVERSITY

In CSIRO, the vast majority of our research is demand-driven (market pull). In any one year we contract with thousands of Australian and multinational firms. We work with existing firms to assist them with product, process and service improvement, including quality control. We also work with existing firms to develop new 'best of breed' products, processes and services.

We are interested in understanding and addressing the needs of firms. For us, 'necessity (firms' needs) is the mother of invention' and subsequent innovation. Our approach is to work with firms to identify solutions and opportunities for their businesses.

CSIRO has extensive national and international networks across governments, research agencies, universities and companies. For example, last year we worked with partners from more than 80 countries. We recognise that we don't have all the answers so we also serve as a value-adding connector to others who can help firms either in Australia or globally. We exist to assist making businesses more competitive and sustainable.

Earlier this year GE released its Global Innovation Barometer report and one of the most encouraging findings was that Australian businesses are seeing the value

of collaboration and working with others in boosting their innovation capabilities. In fact, 92 per cent of respondents surveyed strongly agreed that innovation success rates were higher through partnerships. Despite this expressed view, by global standards Australia has relatively low SME-to-SME, SME-to-MNE (multinational enterprise) and SME-to-research-and-

educational institution interaction.

As a country we are inventive and innovative, but if we are to reach the goal of being in the Top 10 innovation nations then we need to keep thinking of new ways to foster appropriate connections, lift our collaboration and help our industry reach markets both in our region and further afield globally.

Schemes such as the Government's recently announced Industry Innovation Precincts have the potential to have a significant positive impact in addressing some of these challenges by making it easier for firms (small and large), research and educational organisations and individuals to connect and collaborate.

Then there is Enterprise Connect's RIB program. RIB is not just about researchers working on a project in companies. It has a strong cultural element as well. It is important that researchers in publicly funded organisations such as CSIRO and universities develop a greater understanding of industry drivers and needs. This way they can better assist firms. It is also important that companies are exposed to different ways of thinking and doing things in order to grow their absorptive capacity.

A great example of an SME embracing innovation to find a competitive edge

to reach a global market is AW Bell. A family-owned Victorian business, AW Bell specialises in the design, rapid prototyping and manufacturing of complex metal parts in various metals and alloys.

In recent years, the company's competitiveness had been eroded by lower-priced products from Asia. It decided to tackle this by accessing funding through the RIB program. CSIRO's SME Engagement Centre guided the company through the process and subsequently Roger Lumley, one of our metallurgists and casting experts, was embedded within the company.

With Roger's assistance, AW Bell was able to develop a casting process called ABE (Aluminium Billet Equivalent), which produces lightweight, high-strength parts of exceptional quality specifically developed for the aerospace and defence sectors. As a result, AW Bell was granted preferred supplier status, subject to successful first article inspections, by US defence contractor Northrop Grumman.

Another Victorian SME that has invested in technical innovation to maintain its global market advantage, despite Australia's high dollar, is Textor Technologies, which produces products used in applications for the hygiene, healthcare, wipes, industrial fabrics and food-packaging markets.

Textor also applied through the RIB program and, soon after, one of

our senior scientists, Dr Niall Finn, was working with it to develop new and unique manufacturing technologies to improve the performance of its products. In 2011, Textor's success in the market was acknowledged when it was named global supplier of the year by consumer product giant Kimberley-Clark.

Recently, Kimberley-Clark launched its new Huggies nappies line in Australia, also investing \$28 million in new manufacturing infrastructure in Sydney. The nappies feature a new 3D ultra-absorbent material that CSIRO helped co-develop with both Textor and Kimberley-Clark. The Australian nappy market alone is worth about \$500 million each year.

As well as utilising programs such as RIB, CSIRO participates in a wide range of collaborative models that are designed to meet the needs of the participants, to help them improve their current products, processes and/or services, or create new ones. The most common ways we do this are through three basic models: direct bilateral collaboration, pre-competitive co-collaboration and polycollaboration.

Direct bilateral collaboration

CSIRO collaborates with an individual company. The simplest and often the most efficient form of collaboration, this is typically developed through meetings, workshops and other interactions.

For instance, we have been working

with Sydney-based company Direct Nickel for the past three years to test its environmentally friendly processing method that uses and recycles nitric acid and could unlock 70 per cent of the world's nickel supply. Full-scale testing of the process has commenced at a \$3.5 million pilot plant at CSIRO in Perth and, if things continue to progress well, the new method could be ready to roll out to industry as early as 2016.

This is a great example of how working with an individual company not only assists that company to be more competitive and sustainable but also has a potentially huge flow-on effect for the broader industry.

Precompetitive co-collaboration

CSIRO (and in some cases other bodies, such as universities or governments) partner with industry clusters. This type of collaboration is often used where platform technologies are shared throughout an industry sector, with individual firms developing differentiated fields to use the platform.

For example, we work with AMIRA International, which is an independent association of companies created to develop, broker and facilitate collaborative projects. In researching the Bayer process for refining bauxite, together we have delivered successful results and substantial economic returns measured in the hundreds of millions of dollars.

Chubb names five "breakthrough actions"

Australia's Chief Scientist Professor Ian Chubb has released five breakthrough actions governments could take to make Australia a more innovative nation.



Professor
Ian Chubb

They include the establishment of an Australian Innovation Council and helping business access publicly funded research.

The Prime Minister's Science Engineering and Innovation Council agreed that the Office of the Chief Scientist (OCS) would prepare the advice on enhancing productivity through innovation.

The OCS consulted organisations, peak bodies and individuals across the

government, industry and science sectors.

"There was a consistent view on what the breakthrough actions should be. We were told it is not just the effort that is important, but also the scale. Australia already has many support or incentive programs that are considered useful," Professor Chubb said.

"The proposed actions offer the chance of doing things differently to increase the chances of success," he said.

THE FIVE BREAKTHROUGH ACTIONS ARE:

- 1** The establishment of an Australian Innovation Council.
- 2** Strengthening business access to publicly funded research expertise, infrastructure and data.
- 3** Encouraging mobility of researchers between academia and business and other enterprises.
- 4** Harmonising intellectual property frameworks across the publicly funded research sector.
- 5** Emphasising the role of science, technology, engineering and mathematics education in changing the culture.

This relationship has prospered for more than 20 years over a wide range of individual projects.

Polycollaboration

CSIRO partnering with some or all of the following groups: universities, industry bodies, government and individual companies.

Typically in a CRC, we will also be doing this through the new Precinct model.

A good example of polycollaboration is the Victorian Direct Manufacturing Centre (VDMC), which includes nine Victorian manufacturing SMEs, Swinburne University of Technology, Deakin University and CSIRO. Direct manufacturing is a process where components are manufactured directly from powder, ribbon or wire in a layered manner, bypassing conventional processes such as casting, forging, rolling, cutting, machining, welding, or drilling. It offers dramatic savings in labour, time, materials, energy and other costs, and significant reductions in adverse environmental impacts.

The development of a new manufacturing process and infrastructure to produce cost-effective armour for our Defence Force is another great example of this type of collaboration. As part of a Capability and Technology Demonstrator project funded by DSTO, CSIRO scientists developed a smarter processing technique that significantly cuts production costs by more than half and improves the shape-forming process for the protective armour.

Following on from that, four key players in Australian defence innovation (Australian Defence Apparel, the Defence Materials Technology Centre, the Victorian Centre for Advanced Materials Manufacturing and CSIRO) joined forces to build a new, commercially viable manufacturing pilot plant in regional Victoria that can make armour plates using this new technology and allow new prototypes to be developed quickly.

Despite some success stories, as a nation, we need to lift our innovation game to a much higher level. The Australia of the future needs to be far better connected. A national innovation system is at its best when it is highly connected across the elements of MNEs, SMEs, governments, and research and

delivering positive impact for nearly 90 years – means that there is a large return on that four per cent investment.

Return on investment (ROI) is why your national research agency, CSIRO, is considered to be one of the top applied research agencies in the world. ROI is why thousands of firms work with us every year.



CSIRO's Roger Lumley working with AW Bell to develop its casting process.

educational/training institutions.

Collaboration with and learning from one another is value-add and enhances positive economic outcomes. Sustainable wealth creation comes from repeatedly exploiting the link between innovation, productivity and competitive advantage. Australians can only have the long-term societal and environmental agendas we desire if we are sustainably generating wealth to provide the funding pipeline.

At \$1.2 billion a year, CSIRO's share of the national (business and government) investment in R&D is about four per cent. Most Australians are astonished when they first see this relatively low investment percentage.

We project large in the Australian innovation landscape. Our focus on translation of R&D to benefit Australia, especially our passion to assist firms – and our excellent track-record of

We are committed to being a connector in the national innovation system. We see collaboration as catalysing innovation and as a key enabler for firms to improve existing, or create new, products, processes and services to gain that ever sought after competitive advantage.

DR CALUM DRUMMOND FTSE is the CSIRO Group Executive for Manufacturing, Materials and Minerals, with oversight of 1300 researchers and an R&D annual budget of \$250 million. He is a former ARC Federation Fellow and former VP Research at CAP-XX, an Australian company that develops energy storage devices. Dr Drummond is a Director of ATSE and has been a Director of a number of Cooperative Research Centres and member of many university research centre advisory boards and industry councils. He is a Professorial Fellow in chemistry at The University of Melbourne and an Adjunct Professor in chemical engineering at The University of Queensland.

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The University of South Australia (UniSA) is a research leader, recognised on the world stage for rapid research growth and engagement with industry and the community. Our research performance is underpinned by a fundamental commitment to excellence.

As an optimistic and vibrant institution, UniSA is focused on developing a research community that is determined to make a big difference by applying intellect, curiosity and ingenuity to some of the major issues facing the world today.

Our research institutes have the multidisciplinary capability to address research questions across a range of national priority areas including health and medical science, materials and minerals science, social and environmental sustainability, telecommunications, marketing science, and defence and security.

UniSA is in the top 3% of universities worldwide and in 2012 was ranked 23rd in the world for universities under 50.

In the 2012 national Excellence in Research for Australia evaluation, over 86 per cent of the UniSA's assessed research was evaluated as world-class or above with all four of the University's academic divisions represented in the top-tier rankings, with a mix of traditional and emerging disciplines.

The University is ranked 2nd in Australia for CRC income received from the Commonwealth and is a key partner in 13 CRCs with an involvement in over 70 CRC projects, confirming our connectedness to industry through our research.

UniSA's success in securing competitive and industry funding reflects a real confidence in the University's role in breaking new ground and developing knowledge which contributes to significant national research priorities in areas including health, information technology, the environment, economics and business.

To find out more or to be part of UniSA's exciting research future, visit unisa.edu.au/research

"Our commitment to and support for research and its continued growth, makes UniSA a stimulating place to be or engage with; as a student, researcher or partner."



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South Australia**

'Let a thousand flowers bloom' in pursuit of ICT success

Probably the most critical learning for successful commercialisation in the ICT space is the need to imbue an organisational culture that promotes deep research, innovation and entrepreneurship.



By Hugh Durrant-Whyte

hugh@nicta.com.au

National ICT Australia (NICTA) is Australia's centre of excellence for information and communications technology (ICT). NICTA was established in 2003 under the Backing Australia's Ability initiative, with the explicit goal of building research capacity and new industry in the ICT space.

The creation of commercially valuable technology and its exploitation through new and existing businesses in Australia lies at the heart of what NICTA is about.

ICT is the global poster child for the creation of exciting new businesses and transformational products. From smartphones to personalised health, from online retail to robotics, the continuing impact of ICT on all our lives is profound.

Two facts are key to understanding the ICT research and commercialisation process.

First, and most important, the ICT landscape changes at a frantic pace – there is sometimes only a matter of months between having the idea and getting it to market. In this, it is a major advantage that NICTA operates as a (not-for-profit) company, rather than as a government or university institution, as it enables us to be agile, flexible and quick to change tack when required. In the ICT world, those who move slowly are dead.

Second, especially in Australia, by far the majority of wealth-creation outcomes in ICT are not in ICT. Rather the major outcomes are in the application of ICT to real problems in areas

such as health, transport, retail, banking, resources and many others. For this reason, NICTA's commercialisation activities are focused around four business areas:

- Broadband and the Digital Economy (BaDE);
- Health and Life Sciences;
- Infrastructure Transport and Logistics (ITL); and
- Security and Environment.

In each of these areas, NICTA engages directly with existing industry and creates a pipeline of potential new companies. To give a sense of scale, approximately half of all NICTA resources are directed toward these four business teams.

NICTA has created 11 new spin-out companies in total. As might be expected given NICTA's relative youth, the rate of new company generation has been accelerating, with four new spin-out companies exiting in 2012 and 11 more in

the current spin-out pipeline, including five likely to exit within the next 18 months.

Acceleration is a simple fact of growing NICTA's experience in developing and spinning-out technologies. NICTA's earliest start-ups are already building their own ecosystems and spawning new companies themselves. This article gives some examples of NICTA companies that have successfully taken a product to market and tries to distil the approach NICTA has had to start-ups and some of the important lessons learnt along the way.

NICTA's first company, launched in 2006, is [Audinate](#), which has engineering headquarters in Ultimo, NSW. Audinate is a global leader in live sound over Ethernet, distributing audio at major public venues including the 2012 London Olympics. Audinate's strategy has been to focus on a single key technology and to build partnerships with major

Working behind the scenes on the Saluda spin-out



industry players in the audio industry.

Open Kernel Labs commercialised NICTA's OKL4 secure microkernel, which now runs in more than 1.5 billion mobile phones. The company focuses on application of core NICTA research in trusted and secure systems, essentially formal software proof methods. The company went through a number of rounds of venture capital raising and was recently acquired by General Dynamics, a multinational aerospace and defence company.

Nitero was launched in late 2011 as a provider of high-speed, low-power 60GHz wireless chipsets. This company has raised significant venture capital, employs about 25 people and expects its chips to be part of marketable products by early 2014.

In the past year, NICTA has spun-out four start-up companies, two with venture capital backing, one with major 'angel' funding and one bootstrapped from contracts and partnerships. These include **Saluda Medical**, which is building unique neurostimulation pain management technology developed by NICTA's Implant Systems group, and **Incoming!**TM,

a company that exploits NICTA's research in machine learning and network content dissemination in a product designed to help mobile network operators offer a video pre-loading service to their customers.

As should be expected, not all of our spin-out companies have been or will be successful. An appetite for risk and an acceptance of failure as an important 'learning' experience is embraced by ICT business.

NICTA has been evolving a model of how to effect successful commercialisation in the ICT space. Probably the most critical learning is the need to imbue an organisational culture that promotes deep research, innovation and entrepreneurship. Deep research – getting the best possible people working on the hardest and most interesting problems – is fundamental to building the pool of ideas from which serendipity will select the winners.

Innovation and entrepreneurship are really about providing the support, both moral and practical, to assist the transition of ideas, technologies and businesses out of the door.

At a practical level, NICTA business team leaders and business development

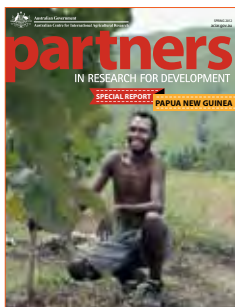
staff support researchers getting ideas out by providing relevant business experience. NICTA proactively trains staff and students in entrepreneurial skills through both courses and engagement in commercially focused projects.

Increasingly, NICTA's engineering group also plays a vital role through its embedding in 'live' projects. Equally, among business and engineering leaders, there is a growing understanding of the commercial landscape both in Australia and internationally, including connections to the venture capital industry.

The main aim of NICTA spin-outs is to create wealth and technology jobs in Australia, and not necessarily for NICTA to make money. We think this makes it easier for researchers to spin-out because the focus is only on them succeeding. When a company is spun-out, NICTA very often provides some seed investment in the form of a convertible note or in exchange for an equity stake. NICTA never takes a board seat. Intellectual property is assigned only according to agreed financial and technical milestones.

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This essentially means that the company must prove itself before it owns the IP.

A final important element for NICTA is our engagement in the 'ICT-ecosystem'. Through our International Business Advisory Group (IBAG) we have some of the very best ICT business people world-wide to advise NICTA on commercialisation strategy. In particular, this group helps introduce projects and business leaders to key international industry and investors.

This also enables NICTA to learn from what is going on internationally in the ICT space and to understand where our work sits in the scheme of things. This is absolutely critical in an industry like ICT where by far the majority of work is undertaken overseas.

At the same time, NICTA engages very strongly with an increasingly vibrant ICT ecosystem in Australia. The return of a number of successful ICT entrepreneurs to these shores and the success of local companies have sparked a wonderful community of new entrepreneurs in the ICT space. There is now a range of new company incubators

A mind map of the Australian ICT ecosystem (courtesy Paul Hoff, NICTA) can be found at <http://bit.ly/AUTechEcosystem>

and accelerators, conferences, hackathons and 'pitch' festivals that together are building a great culture and community for ICT entrepreneurs in Australia.

While we clearly do not have all the answers, NICTA is gradually proving a model and building the expertise for connecting research excellence to wealth creation in the ICT technology industry. Aside from new spin-out companies, we also engage with existing industry through contract research and through technology licensing.

All of these are valid models for getting a product to market and every case will be different. However, the key issues of building the right entrepreneurial culture, providing active business support for our researchers and promoting engagement with the broader community are key to any commercialisation model.

Perhaps the one issue we need to address more broadly as a country, and especially publicly funded organisations

such as NICTA, is our appetite for risk.

It seems clear when we compare ourselves to the really successful precincts and incubators around the world that we simply need to get more technology out of the door, to let go and accept that there is a good chance for failure from which we can all learn – "Let a thousand flowers bloom" (rephrased from Mao Zedong's 1957 rallying speech, meaning encourage many ideas from many sources).

DR HUGH DURRANT-WHYTE FRA FAA FTSE is CEO of National ICT Australia (NICTA). He has published more than 350 research papers and founded four successful start-up companies. He has won numerous awards and prizes for his work, including the 2009 ATSE Clunies Ross Award. A Fellow of the Institute of Electrical and Electronics Engineers (IEEE), the world's largest technical professional society, he was named the 2008 Professional Engineer of the Year by the Institute of Engineers Australia Sydney Division and the 2010 NSW Scientist of the Year. He has been an ATSE Fellow since 2002.

Design integration network to drive innovation

The establishment of an Australian Design Integration Network will develop and promote design-led innovation as part of Australia's new national cultural policy, *Creative Australia*, according to former Arts Minister Simon Crean.

He said the network would promote access to world-class design integration programs, education, skills development and research opportunities for Australian industry to lift industry competitiveness.

"*Creative Australia* will help create new opportunities and new jobs by embedding creative thinking in industry and fostering our high-skill, high-wage economy in the 21st century," Mr Crean said.

The creation of the Australian Design Integration Network will link design-related activities across Australia's innovation system – industry, government, universities and public sector research agencies.

Inaugural membership of the Steering Committee for the network will include representatives from CSIRO, Department of Industry, Innovation, Science, Research and Tertiary Education, Enterprise Connect Creative Industries Innovation Centre, the University of Technology, Sydney, Queensland University of Technology, Swinburne University, RMIT University and Blue Sky Design.

"*Creative Australia* will encourage the creative approach already central to design, marketing, many service sectors and online businesses

– to develop new partnerships with other parts of the economy and drive broad economic growth," Mr Crean said.

"As Australian industries compete in the transforming global economy, the contributions of creative industries will help drive major overall contributions to our national competitiveness, productivity and growth."

The recently released *A Plan for Australian Jobs*, the Australian Government's Industry and Innovation Statement, emphasised that creativity and design thinking were critical enablers of productivity and innovation.

• *The Chair of Telstra, Ms Catherine Livingstone AO FTSE, made a strong appeal for design thinking as an innovation driver in her keynote address to the ATSE Clunies Ross Awards dinner in Sydney last June (right) and in a subsequent article in ATSE Focus 173, August 2012 (page 3).*



Catherine Livingstone delivers her ATSE Clunies Ross keynote address.

LETTERS TO THE EDITOR

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ANSTO commercialisation delivers science benefits to many



The OPAL Reactor: Important to nuclear medicine worldwide.

We will have to expand the range of beamlines, develop the communities that will use them and ensure that we remain at the cutting edge of world-class research and innovation.



By Adi Paterson

sarah.oliver@ansto.gov.au

On 1 January 2013 the Australian Nuclear Science and Technology Organisation took over the day-to-day operations of the Australian Synchrotron, which forms part of the Clayton precinct, anchored by Monash University, CSIRO and exciting initial innovation resources such as the nano-fabrication facility.

The ongoing operating funding of the Australian Synchrotron for the next four years has been secured by a creative partnership between the Commonwealth and Victoria, with unique and significant contributions from New Zealand, and the Australian university community and publicly funded research organisations (PFROs).

The Australian Synchrotron continues to deliver value to hundreds of users annually across a range of fields. No developed country with reasonable scientific aspirations can afford to be isolated from the distinctive capabilities of this type of critical research infrastructure. Australia is no exception.

A recent example comes from the work of Associate Professor Mike Lawrence and

his research team at the Walter & Eliza Hall Institute (WEHI) of Medical Research who published a paper in *Nature* in January outlining in detail (and for the first time) the mechanism by which insulin docks with a specialised receptor on the cell surface.

The 20-year journey to resolving this crucial issue would not have been possible without close association between the Australian Synchrotron and WEHI utilising the MX2 micro-focus beamline. Dr Tom Caradoc-Davies and his team have worked tirelessly to improve the performance of this beamline to ensure that Australian users get the best possible outcomes from their work.

Full potential

The current suite of beamlines has allowed this excellent start. However, in order to realise the full potential of this strategic investment we will have to do what all third-generation light sources have already done: expand the range of beamlines, develop the communities that will use them and ensure that we remain at the cutting edge of world-class research and innovation with a

dynamic and developing synchrotron.

Current operations alone will not be sufficient for us to be proud of our synchrotron in 10 years' time. The current investments in the imaging and medical beamline, for example, are starting to bear fruit. This beamline is intended to be absolutely unique globally, so that our medical community and clinical and translational researchers can better understand disease, normal development of the newly born and also get insight into the complexities of biological systems.

Great credit must be given to the National Health and Medical Research Council (NHMRC), Monash University, the Victorian Government and the original consortium of Foundation Investors in the Australian Synchrotron for their vision in creating the opportunity for this development. Equal credit must go to the exceptional team at the Synchrotron, led by Dr Daniel Hausermann, which is building and commissioning the early experiments at this amazing facility. The team is working to realise the dreams of a future generation of clinicians.

Professor Andrew Peele, the

The 'Big Diff' comes home

Since 1992, the high-tech Photon Factory in Tsukuba, 50 kilometres north-east of Tokyo, has been home to a highly significant piece of Australian research infrastructure called the Australian National Beamline Facility (ANBF).

The ANBF was a visionary project that gave Australian researchers access to a dedicated synchrotron beamline for the first time, without the long lead-times required for access to other overseas synchrotrons.

After more than 20 years' service, the ANBF was retired in March and its iconic instrument, an in-vacuum diffractometer dubbed 'Big Diff', is headed back to Australia to be displayed at the Australian Synchrotron as a reminder of the early days of synchrotron science in Australia.

Synchrotrons accelerate electrons that produce intense beams of light and X-rays for study of matter at the atomic scale. Throughout the 1980s, synchrotron science was at the cutting-edge of materials, environmental, biomedical and mineral science in the UK, Europe, Asia and the US.

Keen to ensure Australian researchers kept up with these revolutionary new capabilities, a group of Australian scientists prompted the Federal Government to entrust ANSTO with establishing a dedicated Australian beamline at the Photon Factory in Tsukuba.

The ANBF ushered in a significant chapter in Australia's scientific relationship with Japan. It led to high-profile collaborations between the two nations in synchrotron and neutron science, including the two countries working together to establish regional Asia Oceania networks in both these fields.

The infrastructure was designed and built in Australia and managed in Japan by three young scientists from ANSTO – Richard Garrett, David Cookson and Garry Foran. After years operating the ANBF beamline and acting as an advisor to the Australian Synchrotron, Garry Foran now works for another research agency in Japan; Richard Garrett is ANSTO's senior advisor in synchrotron science; and David Cookson is Head of Beamline Science and Operations at the Australian Synchrotron.

interim Director of the Australian Synchrotron, is launching an Industry Advisory Committee to add impetus to effective industrial engagement with the manufacturers and specialised science and technology providers in Australia whose day-to-day existence depends on cutting-edge innovation. A review conducted in 2012 identified more than 100 firms in Australia that have already benefited from the Synchrotron indirectly, through their association with work conducted by university and public research agency users.

This is good news for enhanced product development, the introduction of smart new industries and our ability to harness the intellectual power of partnerships between science and industry. Classical micro-economics breaks down and routinely underestimates the power of innovation networks and their sustaining effects on economic development, especially in small nations.

To support our full participation in the next generation of cutting-edge products and better healthcare outcomes for our 23 million people, undertaking our scientific endeavour at world-class Australian facilities is a high priority.

Judicious use of 'suitcase science' and the foresight of the Commonwealth Government allowed us to operate a synchrotron science program in Japan for 20 years. The Australian National Beamline Facility in Japan trained a generation of Australian synchrotron researchers and was a crucial first step in the establishment of a world-class synchrotron-user community in Australia and the decision to fund the Australian Synchrotron.

This venerable facility celebrated its 20th anniversary in February this year and is now being retired from service. The iconic Australian-designed and constructed "big Diff" X-ray diffractometer that served the first generation of synchrotron scientists will return from Japan and go on display in the National Centre for Synchrotron Science at the Australian Synchrotron.

Australia has benefited greatly from the friendship of Japan, the US and Taiwan in developing a vibrant synchrotron community. We now have an obligation in our region to catalyse a generation of synchrotron scientists from developing countries and emerging economies who will celebrate their partnership with us in their turn over the next decades. We

cannot be selfish with our superb scientific infrastructure and we cannot be forgetful of the generosity of the community of science of which we are privileged to be a part.

Nuclear medicine

The most-used diagnostic isotope in nuclear medicine is technetium-99m. It is a decay product of molybdenum-99 (Mo-99) which is produced mainly by the fission of uranium targets in research reactors. ANSTO produces the isotope, which results in some 10,000 doses per week of technetium-99m (Tc-99m) in 224 hospitals and clinics across Australia and New Zealand.

There is an impending global crisis for the nuclear medicine community that delivers more than 40 million diagnostic procedures annually. The research reactors that are responsible for 70 per cent of the world's Mo-99 production are due to be closed down in the next few years.

ANSTO, working closely with the global community, has developed a plan that will permit the OPAL reactor to become the anchor for an expanded capability to deliver around 20 per cent of global supply from 2016, when the major current global producing reactor will cease operation. The Commonwealth Government announced the funding, which will be in the form of \$168 million to build a world-class nuclear medicine production facility and will allow ANSTO to become part of the global supply chain.

ANSTO meets all of the requirements for the production of this critical nuclear medicine using only low-enriched uranium (thereby avoiding any problems of nuclear proliferation) and, in addition, is working closely with international agencies and producers to develop the supply chains that will sustain this industry for the foreseeable future. For example, during May this year ANSTO will deliver Mo-99 to the US, where it is already licenced for sale in generators that produce Tc-99m. It is to the credit of ANSTO's dedicated engineers, reactor operators and production staff and our nuclear medicine supply teams that we have been able to meet the stringent regulatory requirements that permit this crucial supply.

Synroc breakthrough

Most science and engineering professionals in Australia will have heard of Synroc*.

This iconic breakthrough in wasteform science has still to reach its full potential. At present there is no full-scale commercial facility anywhere in the world that utilises Synroc technology. However, with the Government's commitment of funding, ANSTO will design and construct the first Synroc plant, which will be dedicated to the treatment of intermediate-level liquid waste generated as a result of the production of Mo-99.

This plant will demonstrate, at scale, that Synroc technology is ready to be deployed in many global settings where complex and sometimes intractable nuclear wastes need to be safely encapsulated in an economic wasteform. The glint that first appeared in Ted Ringwood's eyes as his uniquely inventive mind was applied to the elegant chemistry that became Synroc will be vindicated in the first economic and practical realisation due to be delivered in 2016.

This is another great example of Australian innovation moving from the laboratory to the factory floor. For our continued economic and social benefit more are required

In this critical era when we need to practically realise the potential for smart manufacturing and valued engineering solutions in a globally competitive world, the Australian Synchrotron, the OPAL reactor, innovation in nuclear medicine and the realisation of the Synroc dream reveal how publicly funded research organisations can create value that underpins the development and future success of Australia.

** Synroc is a particular kind of synthetic rock invented in 1978 by the late Professor Ted Ringwood of the Australian National University. It has since diversified, but generally speaking is an advanced ceramic, comprising geochemically stable natural titanate minerals that have*

immobilised uranium and thorium for billions of years. These can incorporate into their crystal structures nearly all of the elements present in high-level radioactive waste (HLW) and so immobilise them. ANSTO has been developing the technology for more than 30 years.

DR ADI PATERSON FTSE is the Chief Executive Officer of the Australian Nuclear Science and Technology Organisation, with oversight and responsibility for ANSTO's multi-faceted portfolio of activities. ANSTO is undergoing strong growth in capital and innovation programs through new developments in accelerators and beam instruments, and other large-scale infrastructure projects. He works closely with the engineering community on energy issues and is a member of the Engineers Australia National Committee on Fuels and Energy and a member of the Dean's Industrial Steering Committee, Faculty of Engineering at the University of NSW. In 2012 he was named NSW Professional Engineer of the Year by Engineers Australia.

ANSTO marks 60 years

It's 60 years since Australian scientists started to establish on bushland on Sydney's outskirts one of Australia's most significant science facilities, the Australian Nuclear Science and Technology Organisation (ANSTO).

Australia Day 2013 marked 55 years since Prime Minister Sir Robert Menzies 'flicked the switch' and turned on Australia's first nuclear reactor, which would become a tool for advanced scientific research and produce nuclear medicines that would benefit millions of Australians.

Today, one in two Australians benefit from nuclear medicines manufactured at ANSTO, which help diagnose and treat heart disease, cancer, and muscular and skeletal conditions. Broader benefits come from its advanced environment, climate change and industrial research.

ANSTO's Chief Executive Officer, Dr Adi Paterson FTSE, said ANSTO was developed with a great pioneering spirit, a thirst for new knowledge and a deep understanding of the potential of nuclear science and technology to deliver new answers for science and solutions for industries.

"Today ANSTO enables environmental scientists, biologists, geneticists, material scientists and many others to use nuclear techniques to inform their research and deliver new insights that are helping to address some of the big issues of our time, particularly surrounding health and climate change."

The former Minister for Tertiary Education, Skills, Science and Research, Senator Chris Evans, said: "Like CSIRO, ANSTO is one of Australia's largest public research organisations. The research undertaken by ANSTO is both nationally significant and internationally recognised."

"Importantly, because of ANSTO, we are making great progress in techniques which are providing new insights into the research of Alzheimer's and Parkinson's diseases. We're also exploring alternative fuels, working to understand climate change and much more."

Australia's Chief Scientist, Professor Ian Chubb AC, said: "ANSTO plays an essential role in achieving our country's research priorities and regularly introduces nuclear innovations, for the benefit of all Australians, especially in the field of nuclear medicine."



Robert Menzies throws the switch on the HIFAR reactor in 1958, watched by Professor Charles Watson-Munro, Chief Scientist of the Australian Atomic Energy Commission (AAEC).

CHARLES WATSON-MUNRO

In 1955 Charles Watson-Munro took up his appointment as Chief Scientist of the Australian Atomic Energy Commission (AAEC), established under the *Atomic Energy Act 1953* with a wide range of functions and powers.

In the first few years, the AAEC focused on the development of an Australian uranium mining industry and initiating an R&D program. One of the main objectives of the latter was the development of a joint R&D program with the UK, which had already undertaken a vast amount of work on reactor design and on the peaceful applications of nuclear energy, particularly its use in electricity generation. Shortly after his appointment, Charles joined the group of AAEC staff working at Harwell, Oxfordshire, on the joint program.

In 1957 Charles returned to Australia to take direct charge of the research program and oversee the final stages of construction of the research reactor, HIFAR (High Flux Australian Reactor). The reactor, essentially the same design as the UK reactor DIDO, went critical on Australia Day 1958 and has proven a remarkably successful research tool and important source of radioisotopes for industry, medical diagnostics and the environment.



Nuclear Energy for Australia?

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Are nuclear power stations safe? What would we do with the wastes? Where would such power stations be located? How would they be cooled? Are they dangerously radioactive? Can they be the source of nuclear weapons? Is the regulatory environment adequate? On the other hand – Could they reduce emissions and help Australia meet its carbon reduction targets? Would they provide low-cost baseload power, able to charge low-emission electric vehicles at night? Would they provide high level secure jobs – and more?

► KEYNOTE SPEAKERS

Professor Peter Guthrie | *Professor of Sustainability, Cambridge University, UK*

Dr Ron Cameron FTSE | *Head of the Nuclear Development Division, OECD Nuclear Energy Agency, France*

Mr Lee Hee-Yong | *Senior Vice President, Overseas Nuclear Power Projects, KEPCO, Korea*

Dr Massimo Salvatores | *Senior Scientific Advisor to the Director of the Nuclear Energy Division of the CEA, France*

Mr Timo Äikäs | *Executive Vice President, Posiva Oy, Finland*

The **Academy of Technological Sciences and Engineering (ATSE)**, an independent body of professional engineers and technologists, believes the hesitant debate on nuclear energy in Australia needs to be responsibly refocused and reliably and factually informed. It is bringing together highly respected international and national speakers – representing the broad spectrum of opinion on nuclear power – to lead open debate in this two-day seminar on the key technological, economic, social and environmental issues relating to nuclear power generation.

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Turning great ideas into defence capabilities

The transfer of technology is critical for the transition of our science and technology into equipment and resources for the Australian Defence Force, whether on land, at sea or in the air.



By Alex Zelinsky

alex.zelinsky@dsto.defence.gov.au

When soldiers in Afghanistan reported the weight of their body armour was impacting on how they conducted operations, Defence moved quickly. This was the beginning of a collaborative arrangement between the Defence Materiel Organisation (DMO), the Defence Science and Technology Organisation (DSTO) and the Australian Army, which eventually broadened to become Diggerworks.

Diggerworks is a unique collaborative arrangement driven by the end-user, Army. It includes Defence's research and development arm (DSTO), Defence's acquisition authority (DMO) and Defence's Capability Development Group and leverages a new program in the Defence Materials Technology Centre (DMTC).

Diggerworks has enabled a faster entry into service of innovative technology aimed at meeting the current operational needs of Australian soldiers.

It became clear soon after the Afghanistan deployment that changes to the body armour of soldiers was required, but the solution wasn't straightforward. DSTO helped form a multidisciplinary team to work on body armour that enhanced protection and performance. DSTO scientists researched mobility, organ vulnerability, usability and anthropometry to help inform decisions on the balance between the weight burden that soldiers had to carry and protecting them from harm.

Several iterations of improved body armour were issued to soldiers in theatre while work continued to develop this capability using an iterative design process. This work is still continuing, now under the direction of Diggerworks.

The prime focus of our work at DSTO is on keeping Australia's defence

and national security capabilities at the leading edge. The transfer of technology is critical for the transition of our science and technology into equipment and resources for the Australian Defence Force (ADF), whether on land, at sea or in the air.

Our goal, particularly when Australia is actively involved in operations, is to minimise the transition time from R&D to having the best equipment in the hands of the war fighter. The goal of maximising commercial returns from technology transfer is a lower order priority for DSTO.

The DSTO research into body armour performance and protection attributes feeds into DMO specifications for purchase. Industry benefited by having access to this data, short-cutting the development process, and was able to deliver a product well suited to purpose in a shorter time. Importantly, soldiers got what they needed in the shortest possible time.

Innovative technologies developed for defence purposes can result in high-impact success, both in the defence sector and in the wider civilian market. Collaboration with industry is often the key to ensuring science and technology solutions developed in our laboratories are quickly turned into effective assets for the ADF. Licensing and selling our intellectual property are tools for technology transfer.

A recent example of our collaboration with industry that resulted in a fast-tracked solution into ADF operations was the airborne ultrahigh frequency (UHF)

transponder for radio relay, a project known as AUTRY. The scarcity of UHF satellite resources in the Middle East (which constrain operations) and the success of a balloon-borne radio relay project prompted the idea of developing a radio relay that could operate on an unmanned aerial vehicle (UAV). DSTO worked with Long Distance Technologies (later to become part of RF Industries) and RFI to design, make and improve BATS (balloon as a temporary satellite), as well as on AUTRY.

Once the technology proved effective – which included collaboration with a UAV manufacturer and operator – DSTO worked with AAI Aerosonde to integrate AUTRY on Aerosonde UAVs, with Insitu Pacific to integrate it on Scan Eagle UAVs, and with Israeli Aerospace Industries to integrate it on Heron UAVs.

Sharing knowledge and expertise between collaborating partners resulted in vastly improved communications for ADF operations, with the bonus that soldiers were able to use their usual radio equipment rather than specialised satellite communications gear – a much appreciated weight-saving. Our industry partners benefited from the additional capability and the added versatility of their products.

Among the most effective collaboration mechanisms we use are partnership arrangements that bring together industry, publicly funded research agencies, universities and include the client into a new entity with a strong focus.

The Defence Science and Technology Organisation (DSTO) is part of Australia's Department of Defence. It is Australia's second-largest publicly funded research agency, employing some 2400 people with a budget of \$440 million. DSTO is a national leader in safeguarding Australia by delivering valued scientific advice and innovative technology solutions for defence and national security.

The Defence Materials Technology Centre (DMTC) is one such body. Established in 2008 using the successful Cooperative Research Centres model, DMTC undertakes research projects to develop advanced materials and manufacturing processes that support the acquisition and sustainment requirements of the ADF.

Such forms of collaboration can produce exciting individual outcomes for all parties, but when they work together the impact can be even greater.

During 2012, Diggerworks partners worked with DMTC on the personnel survivability project to enhance the soldier combat system. DMTC brought together CSIRO, industry partners and academia for their various skills, including expertise in textiles and manufacturing technologies.

The centre provided a mechanism for new and existing concepts to be matured in specific areas aimed at delivering a high-performance soldier body armour ensemble. All the intellectual property that is developed is owned by DMTC, however Defence and industry have free licence to exploit it.

These DSTO successes are the latest in a string of outcomes that stretch back decades. Few people outside defence circles have heard of Nulka, a unique rocket-propelled active decoy that protects ships by enticing missiles away from their targets. It was conceived by DSTO and developed collaboratively with the US Navy. Nulka has been fitted to more than 150 Australian, US and Canadian warships. Nulka has reportedly earned more than \$800 million in export revenue for BAE Systems Australia over the past two decades.

The Australian Minesweeping and Support System (AMASS) developed by DSTO is another significant commercial success, generating more than \$60 million in export sales for the manufacturers and over \$1.86 million in royalties in the past 10 years. AMASS provides inexpensive mine-hunting, enabling a range of small craft to be rapidly converted into mine sweepers or mine surveillance vessels. The technology was licensed to ADI Ltd (now Thales) in the 1990s and has since been acquired by nine navies across the world.

AMASS exemplifies best practice by contributing to Australia's defence capability while engaging industry as



Developing body armour to protect the Diggers.

a partner in a genuinely collaborative project that shares risk and generates significant income and exports.

Another landmark has been DSTO composite bonded technology to repair damaged aircraft structures. This innovative solution has been applied to Royal Australian Air Force (RAAF) and US Air Force aircraft in addition to civilian aircraft. The technology, licensed to Australian company Helitech Industries, has been marketed successfully overseas over the years. Importantly, the use of this technology has saved the RAAF many millions of dollars in aircraft repair costs and our aircraft have spent less time on the ground.

Other DSTO-developed defence technologies have found a market because they have offered attractive potential for civilian applications. A range of defence sonar technologies have been adapted for the mining exploration sector. As well, the Laser Airborne Depth Sounder is used in many countries for coastal surveys and the Starlight computer security system is being marketed globally under the brand name Veto. In all these cases, industry was intimately involved in the technology transfer process.

In the future, DSTO will place an even greater emphasis on collaboration that produces positive outcomes for all partners: defence and national

security, industry, research agencies and universities. To maximise the chances of success, DSTO will collaborate more broadly and will engage earlier.

The Defence Capability and Technology Demonstrator program, managed by DSTO, is another avenue to assist in accelerating technologies through the stages of development. The program provides Australian and New Zealand industry with the opportunity to demonstrate how new technology can meet defence capability requirements. It provides vital funding for industry to develop their technologies, thus opening potential new markets for companies and adding to the sustainment of an indigenous defence industry base. Since the program began in 1997, Defence has invested \$250 million in 104 projects, half of the projects with small to medium enterprises.

The DSTO policy on technology transfer operates in accord with both the Australian Government and Defence intellectual property (IP) policy framework. Our approach is to use IP for the primary benefit of Defence and transfer technology in partnership with industry where it provides an enhanced capability to Defence. We do not invest in a technology solely for transfer to civilian markets or to raise revenue.

The global partnerships and collaborative programs we have with



Enhancing radio transmissions using AUTRY-equipped unmanned aerial vehicles.

other governments, universities and industry ensure we leverage the maximum benefit from the broader science and technology base, both in Australia and overseas. Through these interactions, we have access to the brightest minds and the best facilities around the world.

The likely continuation of tight fiscal budgets is providing DSTO with additional incentive to closely look at innovative ways to transfer our

technologies. We are planning to build on our success in collaboration and to take advantage of new opportunities. We plan to build strategic alliances with industry, academia and research agencies to create broader pathways for technology transfer.

Our strategic alliances will include a new framework that spells out the intellectual property arrangements up front, with a clear path for its use. Our flexible approach means Defence will

have access to IP without necessarily owning it, except where required by international agreements or national security obligations.

In addition, DSTO will actively participate in the recently announced Industry Innovation Precincts, designed to foster collaboration between companies and research agencies, create new growth and business opportunities.

Importantly, by seeking to partner more widely with industry and R&D providers, DSTO can become an integrator of innovation. Through increased collaboration and partnerships that are purposeful, I am confident that DSTO can decisively contribute to maintaining Australia's leading edge defence and national security capabilities.

DR ALEX ZELINSKY FTSE commenced as Australia's Chief Defence Scientist in March 2012 and leads DSTO. Previously he was Group Executive for Information Sciences at CSIRO and earlier was CEO and co-founder of Seeing Machines, a computer vision systems company, a start-up from the ANU where he was Professor of Systems Engineering. Dr Zelinsky has extensively advised federal and state governments in Australia and has served on the advisory panels to the ARC. He has received numerous awards, including the ATSE Clunies Ross Award, several Australian Engineering Excellence awards and the Eureka Science Prize. He has been named by Engineers Australia as one of Australia's 100 most influential engineers since 2008.

ANSTO and DSTO link to keep Australia safe

ANSTO and DSTO have signed a new agreement and will work together on a number of projects including a Whole-of-Government Radiological and Nuclear Gamma Spectrum Database, which will enable Australian emergency services and federal and state law enforcement agencies to more rapidly identify and deal with suspect objects.

ANSTO Chief Executive Officer Dr Adi Paterson FTSE said this



Adi Paterson and Alex Zelinsky sign the agreement.

collaborative approach by top Australian minds meant a risk-mitigated approach for emergency personnel dealing with serious situations.

"The thinking behind this project means a quicker and more effective response from emergency services, better protection for personnel and, overall, a safer Australia."

"Understanding radioactivity is crucial to developing the safest possible response. This database will help emergency services understand the material they might be dealing with and how best to safely manage it," said the head of DSTO, Chief Defence Scientist Dr Alex Zelinsky FTSE.

The database is the latest in a series of collaborations between ANSTO and DSTO, which have included building a robot with a radiological sensor payload aboard to allow remote detection of potential radiological threats.

DSTO recently assumed responsibility for coordinating whole-of-government science and technology research for national security. ANSTO is home of Australia's nuclear expertise and is custodian of the \$460 million OPAL research reactor, which is used for a variety of environmental, medical and industrial purposes.

A CRC-ACS Thermoset Composite
Welding demonstrator.

CRCs – from dental health to Dreamliner welding

Thermoset Composite Welding – the aim is to use this Australian developed and owned intellectual property for structural assembly of fuselages.



By Tony Peacock
tpeacock@crca.asn.au

The Cooperative Research Centre (CRC) Program was designed to bring together researchers and industry to apply research to major challenges. The Commonwealth provides funds on a competitive basis and the CRC gets some big advantages:

- the scale to achieve things – the average annual Commonwealth contribution to a CRC is \$3.7 million;
- the timeframe to pursue things – most CRCs are funded for seven-year terms and the Commonwealth has renewed many of them beyond that time; and
- the culture to get things done – end users

of research are put in the driver's seat.

About 200 separate CRCs have been funded since the inception of the program in 1991 and the many reviews of the program have some great results. The latest review of the impact of CRCs conducted in 2012 by the Allen Consulting Group indicated a return of 3.1 to 1 on Commonwealth funds and that the program generates around 0.03 percentage points of additional GDP growth per annum. The majority of the increase in GDP has come about from increased export earnings. Sometimes those export earnings can come from sources that the average Australian may know little about.

Recaldent

Recaldent™ is derived from milk casein and enables calcium phosphate and fluoride to bind to tooth enamel. The special ingredient for Recaldent™ is refined in Australia and is exported to be used in a range of products that are improving the teeth of people all over the world. It resulted from years of research at The University of Melbourne and the Oral Health CRC.

Dental decay starts when bacteria in plaque produce an organic acid that dissolves the tooth enamel, breaking down the calcium and phosphate in tooth

enamel. Professor Eric Reynolds AO FTSE and his co-workers showed that the loss of minerals is not irreversible. By delivering calcium and phosphate ions into the tooth through Recaldent™ they could actually repair and strengthen areas of previously damaged enamel.

The Tooth Mousse™ range is a topical crème containing Recaldent™, but Recaldent™ is also used in a variety of products including chewing gums, which are particularly popular in Japan. Recently MI Varnish™ has been released for the treatment of hypersensitive teeth.

The Chief of Pediatric Dentistry at Geisinger Medical Center in Danville Pennsylvania, Dr Lance Kisby, says: “MI Varnish™ has been an important asset for our pediatric population”. He has found the product particularly useful for special needs patients where “it can be challenging doing dental exams and applying conventional fluoride, but MI Varnish™ has made it much easier and these patients have a positive dental experience”.

Composites

Australia's research strengths directly contribute to building industrial strength. The CRC for Advanced Composite Structures (CRC-ACS) has built a global reputation over more than 20 years in the CRC Program. It is one of only a few CRCs to be funded by the Commonwealth for four terms.

Through this CRC, Australia has

gained great opportunities to participate in aerospace design and manufacturing worldwide. For example, some four per cent of Boeing's new 787 Dreamliners are made in Melbourne, providing a \$4 billion, 25-year contract with high-end manufacturing jobs. EADS Australia Pacific, part of the world's largest aerospace manufacturer, the European Aeronautic Defence and Space Company, has a major R&D program in Australia through the CRC, as does the DLR – the German Aerospace Center.

The CRC-ACS Chief Executive Officer, Professor Murray Scott FTSE, is excited about new composite assembly technology that was conceived in the CRC's second term, developed in its third and is being commercialised in its fourth. He says TCW – Thermoset Composite Welding – will become a major technology in the aerospace industry of the future.

“We've worked with Airbus for over 17 years now, but they only joined the CRC formally in its most recent renewal. In the near term, we are working with them to use TCW for rapid attachment of components inside an airframe. In the longer term, the aim is to use this Australian developed and owned intellectual property for structural assembly of fuselages.”

Professor Scott agrees that the scale, timeframes and culture of CRCs are keys to their success.

“It can be 20 years to get an idea into a production aircraft – and of course we are trying to shorten that to 15. Innovation in

aerospace is a long and expensive process and if Australia is going to maintain engagement in the area, we need scale.

“These Aerospace companies look globally for technology and they go to the best – therefore we must have the best ideas in the world. It's a mark of our achievement and of the CRC program that the global aerospace industry is coming to us to adopt our technologies and work with our experts.”

Outside of aerospace, Professor Scott says there are many spill-over opportunities and CRC-ACS's spinoff company, ACS Australia Pty Ltd, is successfully exploiting these opportunities in the oil, gas and petrochemical sector together with CRC-ACS's Malaysian Participant PETRONAS, as well as in a variety of other industries.

PROFESSOR TONY PEACOCK is the Chief Executive of the Cooperative Research Centres Association and Chief Executive of the Invasive Animals CRC (since 2005) and the Pest Animal Control CRC (since 2001). He was Managing Director of the Pig R&D Corporation 1996–2001. He is a passionate advocate for applied research and was the 2010 winner of the Australian Government Eureka Prize for Promoting the Public Understanding of Science. Professor Peacock has worked at the universities of Sydney, Melbourne and Saskatchewan. He has served on the Board of a number of start-up biotechnology companies, is a Fellow of the Australian Institute of Company Directors and is an Adjunct Professor at the University of Canberra.

Three new CRCs funded

The Gillard Government will invest more than \$70 million to help Cooperative Research Centres (CRCs) improve the lives of Australians by driving world-class research in areas including cell therapy, autism, eye care in remote communities and workplace safety.

The Australian Government will fund three new CRCs focused on: alertness, safety and productivity; cell therapy manufacturing; and living with autism spectrum disorders; and provide additional funding to the existing Vision CRC to expand its research programs.

The CRC for Alertness, Safety and Productivity will receive \$14.5 million to reduce the burden of impaired alertness on the safety, productivity and health of all Australians.

The CRC for Cell Therapy Manufacturing will receive \$20 million to

help make Australia a world leader in the manufacture of cell therapies, which offer exciting possibilities for a range of previously incurable and difficult-to-treat conditions.

The CRC for Living with Autism Spectrum Disorders will receive \$31 million to enhance the lives of individuals with lifelong development disabilities arising from an autism spectrum disorder.

An additional \$5 million will enable the Vision CRC to revolutionise the delivery of eye care in remote environments by developing a world first, intelligent retinal camera.

These projects – announced in February – were chosen in the 15th selection round of the CRC program. There is \$240 million in available funding for Round 16, which closes in June 2013.

**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



Things moving quickly on the Tokyo Transit System.

ATSE puts infrastructure under the spotlight

The Academy and Infrastructure Australia held a two-day international workshop on infrastructure planning in Melbourne on 9 and 10 April. It aimed to gather key Australian stakeholders, along with international experts, to develop a best-practice model for infrastructure planning in Australia.

The workshop explored existing and new approaches, models and practices for

infrastructure planning and included discussion on the major role that infrastructure planning, expenditure and operation play in the affairs of all governments, the private sector and the community.

Delegates shared experiences and expectations across a range of administrations to highlight successes and to note past problems. They explored national and international best practice, as well as areas where Australia can build upon its current approaches to infrastructure planning.

The invitation-only workshop was limited to 50 senior practitioners and experts drawn from Australia and overseas. It aimed to inform planning practice and policy development in Australia, as well as shape public debate to support better infrastructure planning.

Organised by ATSE's Built Environment Advisory Group, Chaired by Dr Max Lay AM FTSE, and Infrastructure Australia, the workshop attracted a range of speakers including:

- Mr Jose Luis Irigoyen, Director Transport, Water, Information and Communications Technologies Department, World Bank;
- Mr Zhou Xiaoqi, Deputy Director General, Department of Basic Industries, National Development and Reform Commission (NDRC);
- Dr Guy Felio, President, Infrastructure Strategies & Research Inc, Canada;
- Mr Michael Deegan, National Infrastructure Coordinator, Infrastructure Australia;
- Dr Surya Acharya, Senior Research Fellow, Institution for Transport Policy Studies (ITPS), Japan;
- Mr Jordan Schwartz, Manager, Infrastructure Policy, World Bank; and
- Ms Megan Motto, CEO, Consult Australia.

ATSE President Dr Alan Finkel AM FTSE launched the workshop and ATSE Fellows participating included Mr Jim Hallion FTSE, Mr Dick Kell AM FTSE; Mr Menno Hennevel, FTSE; Dr Vaughan Beck FTSE; Mr Clive Weeks AO FTSE; Mr David Singleton FTSE; and Professor Mike Xie FTSE.

The Workshop was preceded on 8 April with a free public lecture, organised by the ATSE Victorian Division and RMIT, titled 'Infrastructure for growing cities – the struggle to keep up with demand', which was held at RMIT's Storey Hall in Melbourne. It was chaired by Dr Max Lay, with speakers from the Workshop discussing infrastructure planning and development, particularly for transport, in growing cities.

CATHY FOLEY IS NSW WOMAN OF THE YEAR

Dr Cathy Foley PSM FTSE, one Australia's foremost scientists, has been named winner of the 2013 NSW Premier's Award for Woman of the Year.

Dr Foley, an ATSE Fellow since 2008, was acknowledged for leading the way for women in science and inspiring a generation of young girls to follow in her footsteps.

She is one of a handful of women to hold a very senior position in science. As Chief of CSIRO's Materials Science and Engineering division, she is responsible for about 900 people and a budget of more than \$60 million.

For the past 28 years, she has been actively promoting the role of women in physics and science. Her determination to see women excel in the field has seen her form numerous groups including the AIP Women in Physics Group, Women in Superconductivity and Women in Science Enquiry Network.

She has been the keynote speaker at the Women in Science and Engineering Symposium held at Parliament House in Canberra, she was President of both the Australian Institute of Physics and Science and

Technology Australia, representing more than 68,000 researchers. She has served on several boards and advisory groups, including the Prime Minister's Science, Engineering and Innovation Council.

The award noted that her system for mineral exploration, LANDTEM, contributed to the detection of more than \$6 billion worth of mines worldwide. "She has boldly pursued groundbreaking research and ideas in all areas of science, winning not only numerous accolades but also the respect and admiration of her peers. All of this from a woman who overheard a teacher in high school describe her as not being very good at maths.

"Dr Cathy Foley has proven that particular teacher wrong many times over. Her enthusiasm, professionalism, resourcefulness and pragmatism have made her an ideal role model for young women around Australia, especially in science where there are still relatively few women at the highest levels."

She lobbied for government grants in order to build the Bradfield Park Child Care Centre in 1988. She also established after-school care at

Workshop targets SA's manufacturing sector

ATSE's South Australian Division and the SA Government jointly sponsored a Workshop in Adelaide in February to discuss the state's future manufacturing scene. Its aim was to position industry to capture future markets and opportunities, especially in SA's resource and energy sector, in defence and electronic industries, and in agrifood areas.

The Workshop brought together representatives of government, industry, research institutions and the education sector. The focus was on developing recommendations and actions within the framework of the SA Government's strategy, *Manufacturing Works*, released in October 2012.

Presentations and panel sessions at the Workshop drew attention to the need to capitalise on the private sector adopting a continuous and integrated approach to innovation based on leading edge research. Emphasis was on collaborative approaches involving industry organisations and centres of excellence.

The Workshop was organised in four major sessions focusing on Mining and Resources, Defence, Agrifood, and Emerging Technologies. Experts from world-class businesses in each sector discussed the various ways that government, research institutions, education providers and industry can work together to help transform current manufacturing processes.

An outcome was the development of a

set of recommendations designed to underpin the SA Government's policy strategy set out in *Manufacturing Works*: build, promote and maintain a comprehensive and interactive innovation database and web networking tool covering all South Australian research, business activity and expertise in technology and manufacturing. This Innovation Connector is an essential foundation for many of the following recommendations and actions:

- build world-best collaboration between research institutions and between research institutions and industry;
- educate the community about advanced manufacturing;
- develop our small-to-medium-sized enterprises (SMEs);
- build a community of entrepreneurs;
- support emerging technologies ;
- develop a strategy and plan to significantly lift South Australia's skills base with respect to innovation and advanced manufacturing;
- develop a strategy and plan to reinvigorate the agrifood industry;
- focus on the minerals and energy resources sector as a key customer for South Australian advanced manufacturing; and
- develop South Australian research and expertise in the provision of lower-cost energy.

A series of actions to enable each recommendation to be achieved were also highlighted.

ENGINEERING QUEENSLAND WILL EXAMINE \$10 BILLION POTENTIAL

'Engineering Queensland – a Science and Technology Future for Queensland' is the topic for a joint Academy and University of Queensland (UQ) presentation at the Brisbane Convention and Exhibition Centre (BCEC) on 21 May at 6.00pm.

The event, sponsored by BCEC, will promote discussion on engineering excellence and a science and technology future for Queensland, following a recent report by Professor Graham Schaffer FTSE, commissioned by the Queensland Government, which accentuated the importance of engineering and engineering-intensive industries to the Queensland economy.

The report pointed to growth of the industry having the potential to add \$10 billion each year to the Queensland economy, with Brisbane as a world engineering centre for the global provision of specialist engineering services.

The speakers will be: Mr Charlie Sartain FTSE, CEO of Xstrata Copper, member of the UQ Senate and Chairman of the Advisory Board of UQ's Sustainable Minerals Institute; and Mr Andy Greig FTSE, CEO of Bechtel Mining and Metals, with global headquarters in Brisbane, and head of business in Australia for the Bechtel Corporation – the world's largest civil engineering company.

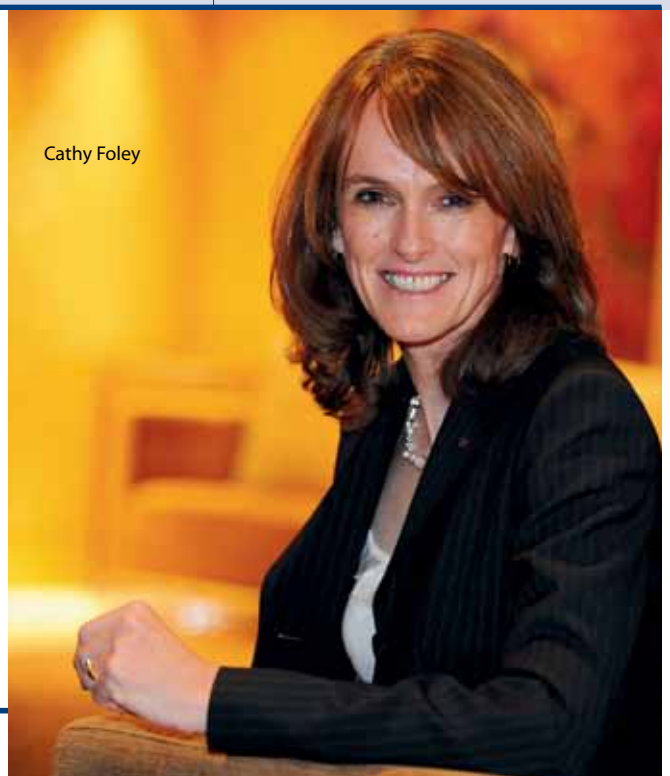
Beaumont Road Public School. She was an active member of Parents and Citizens Associations and School Councils. For this work, in 2006 she was recognised as the NSW Public School Parent of the Year.

A prominent scout leader, Dr Foley started out as secretary of the parent committee for the North St Ives Scout group but since 2001 has been a Joey Scout leader. More than 300 children have been in her group over the years and in 2007 she was honoured for her work with the scouts.

"Being a physicist has been rewarding, not only because it has enabled me to participate in all aspects of science research and its commercialisation and to witness the huge impact this has had on our society, but it has also allowed me to balance my work life with a happy family life and strong community involvement," Dr Foley said.

"It is becoming increasingly clear that the role of the workplace in creating the right environment for women is critical if we are to embrace the full human potential."

Cathy Foley



MARLENE KANGA TO HEAD EA

Engineers Australia, the largest organisation representing the engineering profession in Australia with more than 100,000 members, has appointed Dr Marlene Kanga as National President for 2013.

Dr Kanga is a Sydney-based chartered chemical engineer who specialises in risk engineering.



Marlene Kanga

Dr Kanga is the Director of Business Technology Pty Ltd, a risk engineering consultancy for the oil, gas, and petrochemical sector. She is also a Director of iOmniscient Pty Ltd, which has developed patented software technology for automated camera-based surveillance systems used around the world.

"With Australia's focus on Asia, Dr Kanga is also the first Asian-born engineer to lead the organisation, demonstrating that engineering is a richly diverse profession, as well as being creative and innovative," said Stephen Durkin CEO of Engineers Australia.

"Dr Kanga has made a significant contribution to the engineering profession over the course of her career. This includes chairing Engineers Australia's National Committee for Women in Engineering in 2008 and 2009, championing innovation as chair of Engineers Australia's Innovation Taskforce in 2012, representing Engineers Australia at the World Federation of Engineering Organisations and being part of Engineers Australia's National Council since 2007.

CATRIONA JACKSON HEADS STA

Catriona Jackson is the new CEO of Science & Technology Australia, replacing Anna-Maria Arabia, who has moved to Questacon.

Professor Michael Holland, president of Science & Technology Australia, announcing the appointment, said: "Ms Jackson comes with a 25-year background in politics at the senior level in the federal arena – in Government and Opposition – in tertiary education and in print and radio journalism."

"Most recently she led the Communication and External Liaison Office at The Australian National University and prior to that was a senior staff member for former science and research Minister Senator Kim Carr.

"We have every confidence that Ms Jackson will be a forceful and intelligent advocate for the sector and we welcome her to this challenging role as we enter a critical election year."

ENGINEERING A TOP CHOICE, SAYS DENIZ

When Deniz Kayis started her combined engineering/law degree at the University of NSW this year, she joined a small but growing band of women choosing engineering as a career path. The 18-year-old Sydney Girls' High graduate was one of 7800 students offered a place in UNSW courses in the main round of university offers.

She was also one of more than 40 high achievers scoring 99.9 or above to be given a \$10,000-a-year UNSW Scientia Scholarship for the duration of her degree study.

Pro-Vice Chancellor (Students) Professor Wai-Fong Chua said that increased demand for science and engineering qualifications was particularly striking this year.

"It's particularly pleasing to see we are continuing a steady increase in the number of students attracted to science, which had been struggling nationally in recent years. Compared to last year, we have increased offers to Advanced Science by over 20 per cent," Professor Chua said.

Deniz's decision to accept the UNSW offer continues a family tradition. Her mother, Professor Berman Kayis, is an Associate Professor in the School of Mechanical and Manufacturing Engineering, while her sister Ann has just enrolled in a PhD with the Australian School of Business after completing a combined commerce/law degree at UNSW.

"The combined degree also gives me flexibility and options later on," she said. "If I decide to go down the research path I can choose something that encompasses both – maybe legal issues in engineering – or if I'm working in corporate law, having a background in engineering can help there too."

According to a 2012 Engineers Australia report, female students comprised only 15.8 per cent of commencements in tertiary engineering programs across Australian universities in 2010.

UNSW's engineering faculty wants to boost female enrolments to 25 per cent by 2020 or sooner.

There are already some positive signs. Last year, women comprised around 19 per cent of the UNSW engineering student population, while in particular sub-disciplines such as chemical engineering and biomedical engineering women made up around 40 per cent of students.



Keeping it in the family – (from left) Berman, Deniz and Ann Kayis.

CSIRO launches Digital Flagship

CSIRO has launched Australia's largest publicly funded research initiative

focused on the
digital economy

- its Digital

Productivity and
Services Flagship,
headed by Director
Dr Ian Opperman

CSIRO's 10th National

Research Flagship, it is a \$40 million research initiative focusing on the services sector and optimising the full value of national broadband infrastructure.

The Flagship will initially focus on four key research areas:

- Government Services – develop efficient and effective information use, government services and systems through improved decisions, coordination and customer centrality;
- Commercial Services – with a strong focus on financial services, develop efficient and effective commercial services and systems through better use of capital and improved service delivery models and processes across supply chains;
- Smart, Secure Infrastructure – extending and securing Australia's physical and cyber infrastructure, including the extension of wireless broadband services; and
- Health Services – improving the safety, quality and efficiency of health services for all Australians by delivering technology in partnership with all state government health departments.

The Australian Centre for Broadband Innovation (ACBI) is also a key platform for facilitating new research projects within the Flagship. The goal of ACBI is to develop and test innovative broadband-enabled services, applications and technologies and their use in real-world situations.

Dr Oppermann says the new Flagship is focused on helping Australia transition from being a predominantly resource-focused nation by developing and delivering more efficient and innovative digitally enhanced services.

"Australia is faced with the challenge of maintaining a competitive economic edge in an increasingly complex and resource-limited world," Dr Oppermann says.

"Our labour productivity has declined from about 92 per cent relative to the US in 1998 to about 84 per cent in 2010, meaning Australia's economic prospects beyond the current resources boom will deteriorate significantly if the decline in our productivity growth performance is not reversed.

"A successful digital economy is essential for Australia's economic growth and to maintain our international standing. The services sector represents about 80 per cent of Australia's GDP, so if we are to help Australia grow, we must help businesses and government deliver services in new, faster and better ways.

"CSIRO's expertise in cybersecurity, broadband technologies and services science positions us as the key organisation to take on this

research. While some of our work will be in labs, most of it will happen out in businesses and departments across Australia; finding ways to apply technology to improve the way they deliver their services."

Dr Oppermann says the Flagship has the potential to transform a range of areas, from the way health services are delivered to the way banks manage their funds.

GEELONG OPENS FIBRES RESEARCH FACILITY

The Australian Future Fibres Research and Innovation Centre (AFFRIC) has opened its first operational building at Deakin University's Waurin Ponds Campus in Geelong.

AFFRIC is a \$103 million partnership venture between Deakin University, CSIRO Fibre Materials and the Victorian Centre for Advanced Materials Manufacturing (VCAMM). The Federal Government contributed \$37 million through the Education and Investment Fund.

The Geelong centre brings together Australia's top fibre and manufacturing scientists to conduct research on all aspects of fibre manufacturing, including carbon fibre development, natural fibres, smart fibrous materials and fibres enhanced with nanomaterials.

The newly completed \$26 million first stage of the AFFRIC project provides laboratory, office and conference space to accommodate the colocation of CSIRO fibre and manufacturing scientists who have relocated to Deakin's Waurin Ponds campus. The facility supports shared chemistry and physics laboratories, including microscopy suites that house more than \$20 million worth of high-end instruments for material characterisation.

The co-location of CSIRO with Deakin University is planned to increase the research capacity of both organisations as they work towards helping to revitalise the Australian textile and fibre industries. This will be achieved through the development of innovative materials, including smart fibres that repel water and UV rays, and functional fibres for use in sportswear and protective garments.

Future stages in the AFFRIC building development will include completion of the Fibre Processing Building for use by CSIRO and the Australian Carbon Fibre Research Facility (known as Carbon Nexus). Carbon Nexus will include a pilot scale research plant capable of producing industrial scale quantities of aerospace carbon fibre and enable research into the chemical, mechanical and nanoscale characteristics of the carbon fibre product.

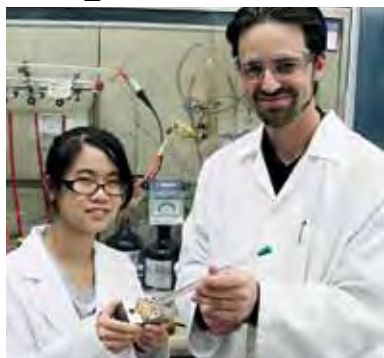
Former Regional Development Minister Simon Crean (front) at the opening of the AFFRIC in Geelong with Deakin Vice Chancellor Professor Jane den Hollander and CSIRO Group Executive, Manufacturing, Materials and Minerals and ATSE Director Dr Calum Drummond FTSE.



Ian Oppermann



Solar sponge soaks up CO₂ emissions



Richelle Lyndon and Matthew Hill with the equipment used to make the 'solar sponge'.

CSIRO scientists have created a 'solar sponge' that captures and then releases carbon dioxide using the power of natural sunlight.

The breakthrough presents a new way to recycle CO₂ emissions using renewable energy. The 'sponge', which is made from a new smart material called a MOF (metal organic framework) adsorbs CO₂ but, when exposed to

sunlight, instantaneously releases it. Known as dynamic photo-switching, this capture-and-release method is extremely energy efficient and only requires UV light to trigger the release of CO₂ after it has been captured from the mixture of exhaust gases.

Dr Matthew Hill, who was awarded a 2012 Eureka Prize for his MOF research, led the CSIRO group conducting this research, published in scientific journal *Angewandte Chemie*.

"The capture and release process can be compared to soaking up water with a sponge and then wringing it out. When UV light hits the material its structure bends and twists and stored gas is released," he said.

"This is an exciting development for carbon capture because concentrated solar energy can be used instead of further coal-based energy to drive the process," he added.

The traditional process for CO₂ capture uses liquid absorbers such as amines to remove flue gases at coal-fired power stations before they are released into the atmosphere. They are then heated to release the CO₂, which is stored and can be re-used. This process can consume as much as 30 per cent of a power plant's production capacity.

MOFs absorb as much as a litre of nitrogen gas in just one gram of material. This is possible because one gram of an MOF has the surface area of a football field, meaning that gases can be soaked up like a sponge to all of the internal surfaces within.

In their paper, 'Dynamic Photo-Switching in Metal Organic Frameworks as a Route to Low Energy Carbon Dioxide Capture and Release', CSIRO researchers show that when exposed to concentrated UV light the MOF sponge instantaneously releases up to 64 per cent of absorbed CO₂.

Lead researcher and author of the paper Richelle Lyndon, who is also a Monash University student, said: "The MOFs are impregnated with light-responsive azobenzene molecules, which react to UV light and trigger the release of CO₂. It is this reaction, and the material's ability to bend and flex, which makes the material we have created so unique."

NOW ON THE LOOSE: 83,000 CHEMICALS

Eighty-three thousand man-made chemicals now circulate freely around the Earth, in water, soil, air, wildlife, food and manufactured goods, and people, posing unquantified but genuine hazards to human and environmental health – according to one of Australia's most distinguished soil scientists, Professor Ravi Naidu, of the University of South Australia and the CRC for

Contamination Assessment and Remediation of the Environment (CARE).

Professor Naidu has just returned from the US where he was admitted as a Fellow of the American Association for the Advancement of Science (AAAS) for "efforts on behalf of the advancement of science or its applications (which) are scientifically or socially distinguished". He was recently awarded the Soil Science Society of America's prestigious 2012 International Soil Science Award.

"When people think of the impact of human activity on global systems, they tend to think mainly of greenhouse gases, urban air pollution or nutrient pollution of waterbodies, but in fact there is a far wider array of toxic substances now in the Earth system circulation," he said.

"These pose real risks to human health. Current studies, such as those by the US Centers for Disease Control, have shown that most humans are now, to some degree, contaminated by industrial chemicals.

"Research in the US, Europe and China is finding many babies are now born contaminated, while mothers are unknowingly passing man-made carcinogens and other toxins to their babies in maternal milk."

Professor Naidu says that the universal nature of chemical contamination of the Earth system is only just starting to be appreciated by science and is still an issue largely unfamiliar to society.

"The water beneath most of our great cities is so contaminated it is often undrinkable. Pesticides and 'gender-bender' compounds are now quite commonly found in the food chain and public water supplies. There is rising awareness of the global distribution of nanomaterials in the environment and a major scientific effort will be needed to understand and monitor this development worldwide.

"While we have some idea of how some individual chemicals affect our health, most of them are unknown and have never been tested – including the many new ones released on world markets each year. Above all, there is little scientific understanding of the impact of chemical mixtures on human or environmental health, which remains a serious gap in our knowledge."

Professor Naidu says Australia is preparing to take a lead in addressing the issue of Earth system contamination. A Global Contamination Research Initiative (GCRI) this will be proposed at a major conference to be hosted by CRC CARE in Melbourne in September.

"The first step in protecting our own health and that of all living species is to understand what is really going on globally – and to do that we need a worldwide team of the best scientists in the field. The GCRI is envisioned as a global scientific partnership that will bring an international focus to an issue which affects all people, everywhere, but has largely gone under the radar."



Ravi Naidu

Looking at the 'carbon budget'

The Australian landscape soaked up a third of the carbon emitted by fossil fuels in Australia over the past 20 years, according to a new CSIRO study.

The study, which marks a major milestone in Australian atmospheric science, also found that Australia exported 2.5 times more carbon in fossil fuels in 2009–10 than was emitted from fossil fuels burnt within Australia.

These results emerge from the three-year study, the Australian Terrestrial Carbon Budget, published in the journal *Biogeosciences* and outlined at the recent Terrestrial Ecosystem Research Network symposium in Canberra.

In the study, scientists quantified how much land carbon is lost or gained through plant and soil 'breathing' in response to variable climate and rising carbon dioxide. Effects of fires, erosion and deforestation were also considered. All these processes together with fossil fuel emissions are critical to domestic carbon management and international reporting protocols. The project centres on the variability of carbon flows for the past two decades and how this period compares with the past 100 years.

Other results include:

- on average, 2.2 billion tonnes of carbon is taken up by plants per year (1990–2011);
- across Australia, grassy vegetation (dominant in dry and savanna regions) accounts for 56 per cent of carbon uptake, while woody vegetation accounts for 44 per cent;
- in wet (high-growth) years, the Australian biosphere 'breathes in' a vast amount of carbon from the atmosphere, exceeding the total of human-induced greenhouse gas emissions, while in dry years, the biosphere 'breathes out' a nearly equal amount of carbon back to the atmosphere – this variability is associated with Australia's highly variable climate; and
- carbon uptake from 1990 to 2011 was high compared with the rest of the 20th century due largely to CO₂ fertilisation.

FISHMAP PLOTS 4500 FISH

FishMap is a free online mapping tool that allows anyone interested in fish to discover what fish species occur at any location or depth throughout the marine waters of Australia's continental shelf and slope.

FishMap has myriad uses: from creating a personalised pictorial guide or identifying fish spotted during a dive, to plotting the range of a threatened species, to improving quality of data collected by citizen scientists, field workers and scientists, to determining the possible species composition of catches of any fishery in the waters of Australia's continental shelf and slope.

The tool provides the scientifically known geographical and depth ranges of more than 4500 Australian marine

fishes, including 320 sharks and rays, of which more than 95 per cent have an associated image or illustration. Searches reveal illustrated

lists of fishes by area, depth, family or ecosystem.

FishMap builds on more than a century of research by Australian ichthyologists and the work of museums and research agencies across Australia, which contributed underlying data and images. FishMap has been jointly funded by The Atlas of Living Australia and CSIRO's Wealth from Oceans Flagship.

"Australia's marine biodiversity is among the richest in world, but until FishMap we lacked an Australia-wide capability to rapidly produce regional, illustrated species lists," says ichthyologist Daniel Gledhill of CSIRO's Wealth from Oceans Flagship.

"FishMap provides a fundamental tool to assist management and sustainability of our marine biodiversity and puts this major capability in the hands of managers, fishers, scientists and the broader public for the first time," Mr Gledhill says.

"FishMap is the only resource of its kind in the world that covers virtually all species of marine fish found in the marine waters of an entire continent."

BIOTECH CROP ADOPTION BOOMING

The global area planted to biotech crops has increased 100-fold since they were first commercialised in 1996, according to the latest annual report from the International Service for the Acquisition of Agri biotech Applications (ISAAA), which also revealed that global adoption of GM crops increased by six per cent last year, to reach 170.3 million hectares.

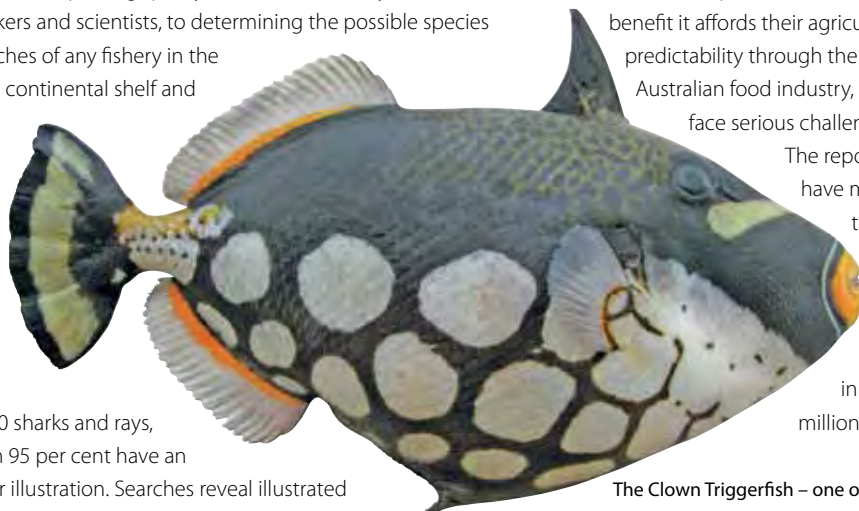
Australia now has the 13th largest area of biotech crops in the world, with a record 700,000 hectares planted – much less than in other countries. Among the emerging countries leading the way on GM crops, Brazil had an increase of 21 per cent compared to 2011 with a total of 36.6 million hectares. Argentina followed with 23.9 million hectares. New countries are now cultivating GM crops, with Sudan and Cuba planting GM crops for the first time in 2012. African countries with commercial plantings of GM crops include South Africa, Burkina Faso, Egypt and Sudan.

"Australian canola farmers compete on global markets with countries like Canada, where a record of 8.4 million hectares of biotech canola was grown last year," said Matthew Cossey, CEO of CropLife Australia.

"Canadian farmers are reaping the benefits of a technology that is not available to Australian farmers in a number of states because of unnecessary and inhibiting regulation.

"Governments in the north and south Americas have decided to accelerate adoption of biotechnology, recognising the massive benefit it affords their agricultural industries. Without improved predictability through the removal of state moratoria, the Australian food industry, commodity traders and farmers will face serious challenges in the future."

The report also shows that biotech crops have made significant contributions to improving agriculture's environmental sustainability. It says biotech crops were directly responsible for reducing CO₂ emissions by 23 million kilograms in 2011, equivalent to removing 10.2 million cars from the road that year.



The Clown Triggerfish – one of 4500 fish species featured in FishMap.

"Fierce" competition for future food needs

The world's demand for food will increase by a massive 75 per cent by the year 2050, putting food security and reform to the agriculture sector at the top of the agendas for business and governments, according to economist Jammie Penm, from the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES).

He told delegates at the ABARES Outlook 2013 conference in Canberra in March that productivity gains would be vital for placing Australia's farmers at the front of those benefiting from the globe's growing appetite for food.

He said increased demand for more food and high-quality products in Asia opened up significant opportunities for Australian agriculture, but competition would be fierce.

"Competition will come from all around the world, but also from increased production in the Asian region, itself," Mr Penm said.

"ABARES modelling shows food production in Asia is expected to

increase significantly to 2050 as countries have greater potential to increase their agricultural productivity. Increased supply from Asia and further abroad is likely to dampen projected price rises in the future. This means Australian farmers will need to boost their productivity to compete."

The Director of Trade and Agriculture at the Organisation for Economic Co-operation and Development (OECD), Mr Ken Ash, said 'business as usual' would not deliver global food security.

"We need an improved climate for trade and investment, demand-driven agriculture innovation systems, more efficient use of land, water and biodiversity resources, and effective risk-management tools."

The Director of the Trade and Markets Division at the United Nations Food and Agriculture Organization (FAO), David Hallam, said: "There are complex economic, political, institutional, legal and ethical issues relating to food security. These also tie in with issues around poverty reduction, rural development, technology and access to land and water resources. Developing countries face the challenge of managing and attracting foreign capital while trying to ensure investments actually deliver benefits to their nations and investors."

LETTER

POSTHARVEST TECHNOLOGY: THE FORGOTTEN SCIENCE TO INCREASE WORLD FOOD SUPPLY

The 2012 Crawford Fund conference and the associated papers published in the December 2012 issue of Focus highlighted many aspects in the quest for food supply to match growing world population and changing food habits. However, there was no mention of postharvest technology as a tool to enhance world food supply.

While postharvest food losses are notoriously difficult to quantify, and can range up to 100 per cent in specific circumstances, it is widely considered that up to 50 per cent of harvestable foods never reach the consumer. The 2011 FAO study (Global Food Losses and Food Waste), concluded that "roughly one-third of food produced for human consumption is lost or wasted globally, which amounts to about 1.3 billion tons per year". Added to this is the under-utilisation of food that is available but not harvested.

Postharvest losses can be through:

- physical loss in transport and storage;
- contamination by pests and diseases;
- loss of quality to a point where the consumer is unwilling to purchase; and
- rejection of edible food through ignorance or custom.

Based on a current 30 per cent global food loss, elimination of postharvest losses would theoretically add 45 per cent to the world food supply. This would be achieved without the need for any additional land, natural resources or farm inputs. While it is not feasible to totally eliminate postharvest losses, it is realistic to expect that a considerable reduction can be achieved, often with relatively simple measures, such as adequate packaging of produce during transport.

Given the enormous potential for enhancing world food supply, where is the attention that the application of appropriate postharvest technologies can deliver considerable benefits to food security? Where are the international research agencies dedicated to postharvest science

and technology? There was a surge of attention in the 1970s and 1980s but action on reducing postharvest losses has since faded. Hopefully the 2011 FAO report will stimulate government action to promote postharvest technology.

Even developed countries can benefit by postharvest technology, although the causes of loss often differ from less-developed countries. However, in Australia the core of postharvest technologists in universities, government and the private sector is dwindling. Paradoxically, the decline is due in part to the growth of research funded by a grower industry levy where research is focused on returns and benefits to producers and production issues and short-term marketing problems are foremost.

Minimising postharvest losses and maintaining product quality are perceived as largely retail and consumer benefits and are therefore someone else's problem – this needs to be addressed.

At a university level, postharvest science is not broadly taught and research is only maintained by postgraduate students from developing countries where there is still an appreciation of how reducing postharvest losses can increase the food supply.

Urgent attention is required to maintain and build the capacity of postharvest science in Australia and in developing countries.

– Emeritus Professor Ron Wills FTSE

• Professor Wills's research at the University of Newcastle focuses on food technology. He has 40 years' experience with food and agriculture commodities at CSIRO, the University of Otago, the University of NSW, Victoria University of Technology and the University of Newcastle, with extensive consulting to the United Nations agencies FAO and IAEA, as well as AusAid in horticultural development projects in Asia. He is a former Director of the Australian Wheat Board's R&D laboratories at Werribee, Victoria.



Telemetry drives auto cattle mustering

An Australian technology company is close to commercialising the world's first fully automated system for mustering and managing cattle in the rangelands. Alice Springs-based Precision Pastoral Pty Ltd has developed the Remote Livestock Management System (RLMS), which can save cattle producers around \$68 a head in annual cattle operational costs. The Australian Government has announced it will provide a \$350,000 grant to help Precision Pastoral to develop, demonstrate and take its automated management system to the Australian and world markets.

The RLMS is a sophisticated combination of hardware and software that uses telemetry to identify, weigh and draft individual animals when they come in for water, explains Tim Driver, CEO of Precision Pastoral.

Precision Pastoral is an IP licensing joint venture company between Ninti One Ltd and CAWD Engineering Pty Ltd. The company has operated since 2009 to develop products and licensable IP for remote livestock management. Ninti One was established in 2003 to conduct research, training and research applications in remote Australia. It also manages IP from its research and administers the CRC for Remote Economic Participation.

The current prototype RLMS is the subject of field trials and research projects with producers throughout remote Australia. Even in harsh conditions, the system has achieved a 92 per cent up-time and a 99 per cent drafting accuracy. In weight-tracking tests, it has recorded cattle weights with 97 per cent accuracy – arguably better humans can achieve.

Mark Ashley, acting managing director of Ninti One, says the technology has the potential to revolutionise the way livestock are managed across the world's arid and semi-arid rangelands.

"It introduces to graziers and pastoralists the same sort of precision available to dairy and beef farmers on much smaller properties – enabling them to muster, weigh, monitor, draft and hold pastoral cattle for market over large distances," he says.

"It saves time, money, labour and capital by using smart remote technology. It can potentially transform the economics and sustainability of extensive grazing in the Australian rangelands – but also in places like the grasslands of Asia, the Americas and Africa."

Mr Driver says the cattle are trained to present themselves to the RLMS for recording, then return themselves to the paddock – unless they are ready for market, in which case a drafting gate sends them to a holding paddock to await collection by the stock transporter.

The solar-driven RLMS 'stockyard' that uses telemetry to identify, weigh and draft cattle when they come in for water..

"It uses solar power to run radio-frequency identification (RFID) readers, which recognise the unique electronic tag in each animal's ear when it passes a gate. The animal is then automatically weighed and drafted. The whole process is overseen by sophisticated software that has been trialled in real-life conditions on Australian cattle stations over the past three years.

"This enables producers to monitor individual cattle whenever they drink and carry out a range of management actions such as mustering, drafting, monitoring calving rates and fertility, controlling access to feed supplements, and tracking animal growth rates to determine optimum sale times."

"No other product on the market comes close to providing this level of integration and data analysis," Mr Driver says.

Mr Ashley says that the RLMS does more than help graziers to monitor and muster cattle 'hands-off' and save money.

"Potentially, it is part of an even more sophisticated system that helps graziers precisely match grazing pressure to the available pasture, as reported by satellites from space. This can help reduce the massive worldwide problem of rangeland degradation by making grazing systems much more sustainable, retaining good cover of native grasses and vegetation – and also locking more carbon.

"The rangelands occupy 40 per cent of the Earth's land surface – the planet's largest area of managed land – but so far humanity has not managed them that well. Precision pastoralism will improve management of both the rangelands and its animals, as well as preserving the pastoral livelihoods of millions of people. This represents a profound contribution by Australian science and technology to a more sustainable world."

GRDC TACKLES GROWING HERBICIDE RESISTANCE

The Grains Research and Development Corporation (GRDC) is supporting the national effort against herbicide resistance, backing WeedSmart – an all-of-industry national program to arm growers and agronomists with the necessary tools needed to fight herbicide resistance on farms.

The GRDC's Senior Manager for Plant Health, Dr Rohan Rainbow, said a collaborative approach to the industry-wide problem of herbicide resistance was needed to protect productivity and preserve long-term access to important chemicals.

"Herbicide resistance costs Australian farmers more than \$200 million every year, a figure that will rise unless growers deal with the onset of herbicide resistance and consider non-chemical ways of fighting weeds," Mr Rainbow said. "The GRDC has played a key role in establishing this program, teaming with commercial organisations, educational institutions, advisers and growers to ensure successful weed management is at the forefront of global farming practice.

"WeedSmart forms part of the \$29 million the GRDC will invest in 2012-13 under its crop protection agenda, which targets the prevention of weeds, pests and diseases inflicting crop yield and quality losses."

The WeedSmart campaign was launched at the Global Herbicide Resistance Challenge in Perth in February. The campaign hub (weedsmart.org.au) contains specific resources for advisers and growers in all regions of Australia. A WeedSmart App (available at weedsmart.org.au/app) provides a simple tool to gauge the risk of developing herbicide-resistant weeds in a paddock and how effectively the weed seedbank is being managed.

Chaney Report makes 35 recommendations



Michael Chaney

The Australian Government has released the report of its International Education Advisory Council (IEAC), *Australia – Educating Globally*, which it is now considering. Known as the Chaney Report (Mr Michael Chaney AO FTSE chairs the IEAC) it includes 35 recommendations addressing seven key issues facing Australia's international education sector: coordination; quality; a positive student experience; partnerships; ensuring the integrity of Australia's student visa program; data analysis and research in international education; and competition, promotion and marketing.

The report, released by the former Minister for Tertiary Education, Skills, Science and Research, Chris Bowen, will help inform the development of a five-year strategy to ensure the sustainability and quality of the international education sector in Australia.

Universities Australia (UA) called it a "well-considered strategy for the development of a vibrant Australian international education sector".

"This excellent report outlines a real and achievable five-year strategy to strengthen international education and we strongly commend it to the government," said Ms Belinda Robinson, UA Chief Executive. "At around \$15 billion each year, international education is Australia's largest export earner after resources, (so) it is crucial we get the policy settings right."

"This report provides a considered analysis of international education in Australia and outlines the challenges and opportunities of coming years. Building on the reforms of the Baird and Knight reviews, it consolidates the improvements to quality assurance and competitive student visa settings."

"A sustainable high-quality international education industry is vital for the long-term prosperity of Australia. Australia's universities have formed the backbone of this industry over the past 25 years, and will continue to both promote and foster international education," Ms Robinson said.

The report says Australia will be able to play a leading role in meeting the growing global demand for education but cannot be complacent about its relatively strong performance in international education to date.

"While historic rates of growth will slow as some institutions reach their carrying capacity, we estimate that the most likely growth path would see Australia hosting around 520,000 students in 2020, studying across all education sectors and contributing around \$19.1 billion to the local economy," the report says. "For the community, this brings direct benefits to retailers, accommodation providers and community enterprises. This will represent an additional 117,000 students over the 2012 level of 402,000 and an estimated increase of 146,000 enrolments from that year."

"Australia should draw on its long, successful experience in international education to move up the value chain and focus on providing a high quality education experience, as well as attracting more students to our Australian and offshore campuses."

The report outlined 35 proposed actions under seven strategies:

- 1** Ensure improved coordination of government policy and programs for international education and better consultative mechanisms for stakeholders in order to optimise government support for the international education sector.
- 2** Position Australia as a provider of the highest quality education, while reducing over-regulation, duplication and overlap.
- 3** Maintain and build on Australia's reputation as an open and friendly learning environment where international students are valued

members of the community and are supported to achieve their goals.

- 4** Encourage Australian institutions and governments to develop strong and diverse international and multinational partnerships that encourage exchange, capacity building and collaboration.
- 5** Ensure that Australia's student visa settings continue to be competitive and attractive in all education sectors while preserving the integrity of Australia's international student visa program and helping to meet national skills needs.
- 6** Inform Australia's international education policy through accurate and timely data analysis and research, as well as supporting increased collaboration between researchers.
- 7** Market Australia as a supplier of high-quality education and continue to build its core markets while pursuing diversification through engagement with emerging markets and increased offshore delivery.

The IEAC was established in October 2011 and includes Professor Ian Chubb AC, Chief Scientist, and leading education and business figures. It provides advice to the Minister for Tertiary Education about the challenges and opportunities facing the international education sector.

Australia – Educating Globally is at www.aei.gov.au

A SMARTER AUSTRALIA: AN EDUCATION ROADMAP

Universities Australia has released *A Smarter Australia: An agenda for Australian Higher Education 2013–16*, which UA Chair Professor Glyn Davis describes as a "roadmap for a smarter, stronger and more prosperous Australia by building on Australia's comparative advantage in higher education". Launching the policy statement at the National Press Club in Canberra, Professor Davis said it responded to four trends driving change in Australian higher education:

- 1** The emergence of digital technologies.
- 2** Increasing globalisation and growing international competition in the Asian century.
- 3** The need for economic and industrial renewal and diversification.
- 4** The need to arrest declining national productivity.

"Australian universities produce the highly skilled graduates that Australia's workforce demands. Through university research programs, new products are invented, new industries created and solutions found for Australia's most challenging problems," Professor Davis said.

He said *A Smarter Australia* calls for a partnership between the university sector and government to establish a practical and pragmatic policy framework around four key themes:

- increasing Australians' university participation;
- developing Australia's globally engaged university sector;
- a powerful research and innovation system that drives economic and social progress; and
- increasing investment, improving efficiency and reducing red tape.

"With 88 per cent of people encouraging their children to obtain a university education, we want to ensure that our universities are equipped to turn this aspiration into graduation. Our vision is for a smarter Australia – one that is prosperous, diverse and proud of its inventiveness. We believe that by following this agenda, our universities can make this vision a reality."

Also released was a short complementary document, *A Smarter Australia: Policy advice for an incoming government*, outlining the sector's five highest priorities for immediate action by an incoming government.

Both documents are at www.universitiesaustralia.edu.au



Danger signals on girls' maths study

The percentage of girls studying no maths at HSC has more than doubled in the past decade, a report by University of Sydney researchers shows.

Honorary Professor John Mack and Barry Walsh examined data of all Year 8 students in NSW to find the proportion who go on to study maths-science subject combinations for their HSC. The data showed a substantial increase in the number of girls studying no maths at all in the HSC and also a substantial drop in the number of male and female students undertaking at least one maths and one science subject in the HSC.

"The decline in maths and science participation coincided with the removal in 2001 of the HSC requirement for at least one course in maths or science," says Dr Rachel Wilson from the Faculty of Education and Social Work, who helped prepare the report. "It's not a requirement in NSW, Victoria or Western Australia; although it is compulsory in South Australia and, to a small extent, in Queensland and the Northern Territory. The study calls for policy change to make these subjects mandatory in order to lift participation in high school and to attract more girls to maths and science."

In 2001, 9.5 per cent of girls undertook no maths in their HSC; in 2011, this figure was 21.8 per cent – more than double that of 10 years previously. In the same period the total proportion of Year 8 girls who went on to study intermediate or advanced maths dropped from 25 per cent to 18 per cent.

In terms of undertaking science and maths the study also showed that only 1.5 per cent of girls and 4.4 per cent of boys go on to study advanced maths with both physics and chemistry.

In 2001, 19.7 per cent of boys and 16.8 per cent of girls studied a maths-science combination for HSC; in 2011 these figures had dropped to 18.6 per cent and 13.8 per cent, respectively. The decline has occurred despite the fact that HSC participation increased by five per cent over the period.

This analysis suggests there is an urgent need to address declining female participation and stagnated male participation in intermediate/advanced maths-science combinations of study. It shows the proportion of girls studying such combination subjects has dwindled since 2001 and there is now a greater gender disparity in maths/sciences participation than there was in the 1980s.

\$12.4 MILLION TO BOOST TEACHER EDUCATION

The Australian Government has announced a new \$12.4 million program – Enhancing the Training of Mathematics and Science Teachers – to improve university training and preparation for maths and science teachers. The program seeks to boost the effectiveness of science and

Professor Nalini Joshi from the University of Sydney – an Ambassador for the International Year of Mathematics of Planet Earth Australia.

maths by better preparing graduate teachers for the classroom.

The Government will invest \$12.4 million over three years from 2014–16 to enable university faculties of mathematics, science and education to collaborate on course design and delivery. Institutions with at least level four Excellence in Research for Australia (ERA) 2012 rating in maths, physics, chemistry, biology, earth science, environmental science or education are eligible to lead projects at the undergraduate or postgraduate level. Applications for program grants close 30 April.

The program is part of the Government's Investing in Science and Maths for a Smarter Future initiative, a response to the report by Professor Ian Chubb AC, Australia's Chief Scientist, *Maths, Engineering and Science: in the National Interest*.

ANU JOINS edX ONLINE EDUCATION REVOLUTION

The Australian National University (ANU) has become the only Australian member of edX, the online learning enterprise founded by Harvard University and the Massachusetts Institute of Technology that aims to provide education to one billion people worldwide within 10 years.

edX announced an expansion of its membership in February to include ANU, Delft University of Technology in the Netherlands, École Polytechnique Fédérale de Lausanne in Switzerland, McGill University and the University of Toronto in Canada, and Rice University in the US.

ANU Vice Chancellor Professor Ian Young AO FTSE said that edX was the right fit for ANU, an institution that prides itself on being at the forefront of new knowledge.

"Nobody really fully understands yet what the impact of massive open online courses (MOOCs) on higher education might be but, just as in other disruptive technologies, the changes could be quite fundamental. I don't think anyone around the world has a full idea of what this looks like in 10 years, so I think it's very exciting to be part of edX, to ensure that ANU programs, the great staff we have and the innovative education we offer are seen by thousands of people around the world," he said.

Professor Young said he believed platforms such as edX would be one element of an online revolution. "I don't think MOOCs are going to supplant what we normally see as full delivery of degrees within our universities, but I think you are gradually going to see more and more students able to access parts of their education through vehicles like edX.

"We at ANU need to be part of this rapid expansion, and edX is an absolutely tremendous platform that enables us, working with a group of other quality institutions, to project our courses and the quality of our education to students around the world."

A key advocate of ANU joining edX was Nobel Laureate and Professor of Astrophysics in the ANU Research School of Astronomy and Astrophysics Brian Schmidt, who will teach one of the first ANUx courses.

The first two ANUx courses will be Astrophysics, taught by Professor Schmidt and his colleague Dr Paul Francis, and Engaging India, taught by Dr McComas Taylor and Dr Peter Friedlander from the ANU College of Asia and the Pacific. Both courses are expected to be beta tested in 2013 and fully operational in 2014.



Ian Young

FUTURE FELLOWSHIPS: The end ignores the national benefits



By Les Field

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When we discover the formula for something that does actually work why would we let it fritter away?

In the case of the Future Fellowship Scheme there's a lot at risk. The five-year scheme's final round has closed with nothing in the wings to take its place and nothing to ensure its benefits don't simply evaporate when the current funding runs out.

The Future Fellowships have brought 200 mid-career researchers each year into the Australian research sector, building a critical mass in research areas that address national challenges and help Australia secure its position in a globalised knowledge economy. At the University of NSW, Future Fellowships have supported the development of world-class research groups and capabilities in a range of disciplines and applications, from quantum computing and photovoltaics to climate

change and sustainable materials. It's no exaggeration to say that much of this talent would have otherwise gone offshore.

Now we find ourselves at yet another research funding crossroads. When the Future Fellowship Scheme was announced, the then Minister for Science, Industry and Innovation, Senator Kim Carr, was understandably passionate about its potential. The plan pushed a number of important buttons simultaneously. It provided a much needed boost to Australia's research capacity in both big and small institutions, and it alleviated some of the uncertainty facing early- to mid-career researchers by offering them a financial incentive to stay Australia as well as a new career pathway forward.

In addition, we had something concrete on the table to combat the long lamented 'brain drain'. With a meaningful number of Future Fellowships on offer every year, Australia has had good research jobs to

counter the ever-increasing international competition for bright minds.

Having now seen a new cohort of innovative, talented, inspiring researchers at UNSW reap the benefits of the Future Fellowship scheme, it seems the only real flaw in the scheme's design was that it was only ever conceived as a five-year plan, and came without an exit strategy.

Research, however, is a long-term undertaking, sometimes very long-term. Our ground-breaking research at UNSW into photovoltaics, which has laid the foundation for much of today's global PV industry, dates back to the 1960s.

I know that most universities have incorporated the Future Fellowships into their own planning, as a means of building on areas of existing strength and to build capacity behind new initiatives. The scheme has been an important mechanism for recruiting the next generation of research leaders.



An artist's depiction of an asteroid mining mission.

Off-Earth mining: sci-fi or reality?

While mining the moon or asteroids is still confined to the realm of science fiction, a growing number of engineers, entrepreneurs and explorers are looking skyward and pondering the prospect of extracting valuable off-Earth minerals.

A future moon colony for the purposes of mining, if it were to become a reality, could also serve as a launching pad or refuelling station for human spaceflight missions further afield.

At the University of NSW, a multidisciplinary research effort is underway in the Faculty of Engineering to explore opportunities for making off-Earth mining viable, and to design innovative methods to build, source power and extract minerals on the moon. UNSW's Australian Centre for Space Engineering Research, in collaboration with the Schools of Civil and Environmental Engineering, and Mining Engineering, hosted Australia's first Off-Earth Mining Forum in February, which featured a keynote lecture by René Fradet, Deputy Director of Engineering and Science Directorate at NASA's Jet Propulsion Laboratory.

The two-day forum featured international experts and Australian researchers in the fields of robotics, mining and spacecraft engineering who outlined ways that Australia could leverage its world-leading strength in mining to become players in this growing research area.

Speakers addressed the motivations for off-Earth mining, the

IMAGE: NASA/DENISE WALT

One of UNSW's highest-profile innovators (and winner of the 2012 *The Australian* Innovation Challenge), Professor Veena Sahajwalla FTSE, has been supported by a Future Fellowship in shepherding her 'green' steel-making process out of the laboratory and into the highly competitive international marketplace. The 'green steel' innovation partially replaces coke in electric arc steelmaking with waste tyres and plastics, utilising high temperatures to literally dissolve the problematic waste streams in new steel. That international commercialisation was achieved within a decade is extraordinary.

Currently one of our strongest research groups, the UNSW-based ARC Centre of Excellence for Quantum Computation and Communication Technology, is looking some 30 or 40 years into the future and is not expected to realise a working computer on the molecular scale for some years. However, last year a team led by UNSW engineers and physicists achieved a globally significant breakthrough by developing a 'single electron reader' – a key building block in creating a silicon-based quantum machine. The ARC Centre, too, has been well supported by key recruits under the Future Fellowship Scheme.

A look at research fellows across the university sector suggests that numbers are currently at close to an all-time high. Australia has multiple active NHMRC

Fellowship Schemes, the tail-end of the tenure of some of the now discontinued ARC Fellowship schemes and the pipeline of Future Fellows built up over the past four years. From here on out, numbers will progressively decline as researchers come off their respective appointments.

Unless we can fill the void created by the loss of the Future Fellowships and other fellowship schemes, it is unavoidable that the research horsepower in Australia will wind back significantly over the next few years.

Governments are accustomed to criticism of their policies, so I was wondering

how they might react to praise. The Future Fellowship Scheme really has delivered; as a sector we need to make this clear.

What we now need is a long-term coordinated research vision to frame such success stories. And, to achieve this, we need to decouple research funding from the kind of short-term thinking that electoral cycles and politicised budget priorities drive.

In an election year, it would be nice to see such a national vision on the table; it's one both sides could, and should, embrace.

PROFESSOR LES FIELD is Deputy Vice-Chancellor (Research) at UNSW.



Veena Sahajwallah at work.

challenges for engineering systems to work in space, business innovations that could make these endeavours viable, and some of the ethical, legal and heritage concerns around mining in space.

GEOSCIENCE LEADER JOINS UWA

Adjunct Professor Mark Jessell, an international leader in structural geoscience and research director at the Institut de Recherche pour le Développement in Toulouse, France, has been awarded a Western Australia Research Fellowship, based at The University of WA's Centre for Exploration Targeting.

UWA Deputy Vice Chancellor Professor Robyn Owens FTSE said the fellowship would enable Professor Jessell to build an international consortium of geoscientists working in the fields of 3D geological modelling and geophysical inversion.

"His specialised focus on advanced 3D modelling will enable greater success in identifying and discovering mineral deposits in Western Australia," she said. "Professor Jessell is already working in collaboration with geoscientists at UWA through his partnership in the industry-funded West African Exploration Initiative stage two.

"His presence here in WA will ensure the translation of his expert knowledge and skills to local students and mine exploration stakeholders. With Perth hosting the second largest number of mining companies in the world, as well as those Australian companies undertaking mineral exploration in Africa, he is a key person to deliver cutting-edge knowledge to their mining exploration."

MITCH HOOKE LEAVES MCA

The Minerals Council of Australia Chief Executive Officer Mitch Hooke will leave MCA at the conclusion of his current contract at the end of 2013. He has held the role since 2002. The MCA Board has commenced succession planning following his decision not to renew his contract.

MCA Chair Peter Johnston said Mr Hooke had had an enormous impact on the mining industry and the Australian public-policy landscape, and had been a tireless campaigner for the minerals sector during some of its most difficult periods. He also focused the industry, with considerable success, on improving its environmental and social performance, as well as enhancing the sector's relationship with Indigenous Australians. The minerals industry is now the largest employer of Indigenous Australians.

Anti-ageing drug breakthrough claimed

Drugs that combat ageing and that have the potential to address a range of diseases, including cancer, Alzheimer's and Type 2 diabetes, may be available within five years, following landmark work led by an Australian researcher.

The work, published in *Science*, finally proves that a single anti-ageing enzyme in the body can be targeted, with the potential to prevent age-related diseases and extend lifespans.

The paper says all of the 117 drugs tested work on the single enzyme through a common mechanism, which means a whole new class of

anti-ageing drugs is now viable, which could ultimately prevent cancer, Alzheimer's disease and Type 2 diabetes.

"Ultimately, these drugs would treat one disease, but unlike drugs of today, they would prevent 20 others," says the lead author of the paper, Professor David Sinclair, from UNSW Medicine, who is based at Harvard University.

"In effect, they would slow ageing."

The target enzyme, SIRT1, is switched on naturally by calorie restriction and exercise, but it can also be enhanced through activators, of which the most common naturally occurring is resveratrol, which is found in small quantities in red wine. Synthetic activators with much stronger activity are already being developed.

Although research surrounding resveratrol has been ongoing for a decade, until now the basic science had been contested. Despite this, there have already been promising results in some trials, with implications for cancer, cardiovascular disease and cardiac failure, Type 2 diabetes, Alzheimer's and Parkinson's diseases, fatty liver disease, cataracts, osteoporosis, muscle wasting, sleep disorders and inflammatory diseases such as psoriasis, arthritis and colitis (inflammatory bowel disease).

"In the history of pharmaceuticals, there has never been a drug that tweaks an enzyme to make it run faster," says Professor Sinclair, a geneticist with the Department of Pharmacology at UNSW.

Professor Sinclair formed a start-up company in 2004, Sirtris, to develop the anti-ageing technology. This was subsequently sold to GlaxoSmithKline (GSK) in 2008. Professor Sinclair is now a scientific advisor to GSK. Several other authors on the paper work for GSK or an affiliated company.

Four thousand synthetic activators, which are 100 times as potent as a single glass of red wine, have been developed – the best three are in human trials.

"Our drugs can mimic the benefits of diet and exercise, but there is no impact on weight," says Professor Sinclair, who suggests the first therapeutic to be marketed will be for diabetes.

There have been limited trials in people with type 2 diabetes and the skin inflammatory disease psoriasis. There were benefits to the metabolism in the first group and a reduction in skin redness in the second. The drugs can be administered orally or topically. So far, there have been no drugs developed that target ageing skin, but one major skin-care range has developed a cream with resveratrol in it.

While any drug would be strictly prescribed for certain conditions, Professor Sinclair suggests that one day they could be taken orally as a preventative. This would be in much the same way as statin drugs are commonly prescribed to prevent cardiovascular disease.



David Sinclair



An image created by vision-impaired researcher and artist Erica Tandori.

STEM CELL BODY BACKS EYE RESEARCH

Melbourne researchers are turning skin cells into eye cells to help them understand an incurable form of blindness that affects one in seven older Australians: age-related macular degeneration.

The new initiative was announced at the launch in February of the National Stem Cell Foundation of Australia, a new charity that is supporting stem cell research, and informing the community of the potential opportunities, and the present dangers of stem cell medicine.

The Foundation's first investment has brought Dr Kathryn Davidson, a young American stem cell expert, back to Melbourne and the Centre for Eye Research Australia. She hopes to help solve the mystery of what causes age-related macular degeneration, a common, incurable and poorly understood cause of blindness that costs the Australian economy \$5.15 billion per year.

"We don't know for certain what's happening in the eye to cause macular degeneration," says Dr Davidson. "We know that certain retinal cells die, and so do the other cells that depend on them, but we need to know how and why. Then we can start to think about early diagnosis and treatment."

"We will take skin cells from the patient, turn them into stem cells and then into new retinal cells. Then we can compare these eye cells with damaged eye cells from the same patients and see what is happening."

The Stem Cell Foundation has been established to support research efforts and provide much-needed public information about stem cell therapies. Kathryn is the Foundation's first research grant recipient.

"Stem cell medicine holds great potential but there are also real risks," says Foundation Chairman Dr Graeme Blackman OAM FTSE, a Fellow since 2004. "Many people are considering expensive and unproven stem cell therapies offered overseas without realising the risks of developing complications and even tumours."

"The Foundation will use the funds it raises to support researchers like Kathryn and also to provide the information patients need to make better treatment choices."

"Australia has a remarkable record of leadership in stem cell science. We want to help Australian scientists turn the potential of stem cell medicine into reality."



Graeme Blackman



Margaret Sommerville (99) and Major Cyril Bunney (98).

Super centenarians' DNA goes into X Prize pitch

Genetic material from 14 of Australia's oldest citizens has been sent overseas in a bid to discover the secret of surviving into old age.

The DNA of the donors, who are part of the University of NSW's Centenarian Study, has been frozen and sent to the US for a competition, with geneticists vying to be the first to map the genomes of 100 people over 100. Run by the not-for-profit X Prize Foundation, the work also presents an opportunity to identify those rare genes that protect against diseases, while giving valuable clues about health and longevity.

"It's significant that we can collaborate in this venture, as it allows the sample of 100 centenarians to be more heterogeneous," says Dr Charlene Levitan, who is part of UNSW's Centre for Healthy Brain Ageing (CHEBA) and the Centenarian Study.

"People born in Europe, the US, Africa and Asia are all included."

Once the genome is sequenced, the team from the Sydney Centenarian Study will have access to the results for one year, allowing them to do crucial work in the field.

"We think about 30 per cent of longevity can be attributed to genetics, but the other 70 per cent is lifestyle and personality factors," Dr Levitan says.

In terms of personality, centenarians and 'super-centenarians' (those over 105 years) are positive, resilient and adaptable, she says. While there is no "exclusive ingredient" that is key to their diets, the ability to maintain a stable weight throughout adult life appears important.

"There are roughly three groups of people who get to 100: a small group of 'escapers' who have eluded age-related major illnesses in life; a larger group – 'delayers' – who have been fairly well up to 80 years of age, but have had ill health after that; and 'survivors', who have survived illnesses such as cancer or heart attacks."

The genomes are expected to be sequenced by the end of the year.

UNSW's Centenarian Study, which began in 2009, focuses on the health of people aged 95 years and over. The goal of the research is to better understand the physical and mental health of people in this category to assist healthcare providers in supplying the right information to people in this group. Individuals over the age of 90 years are the fastest growing proportion of the population. According to the Australian Bureau of Statistics (2006) Census there were 21,805 individuals between 95 and 99 years old and 2860 in the 100+ age group. It is estimated that there will be 12,000 centenarians in Australia by 2020 and 50,000 by 2050; the number of centenarians worldwide is estimated to increase 15-fold, to 2.2 million by 2050

NEW DRUG TO COMBAT FLU PANDEMIC

CSIRO scientists have helped to design a new drug to safeguard against epidemic and pandemic flu strains. The drug has proven effective in preventing the spread of different strains of influenza in laboratory models, including resistant strains of the virus.

The breakthrough, published in *Science*, is the result of a global collaboration between scientists from CSIRO and the universities of British Columbia and Bath.

CSIRO scientist Dr Jenny McKimm-Breschkin, a researcher in the team that developed the first flu drug Relenza, said understanding exactly how flu viruses become resistant to drugs had helped them design a better flu drug.

"CSIRO researchers have shown that flu viruses continually mutate and some have become resistant to available treatments," Dr McKimm-Breschkin said. "The new drug is effective against these resistant strains. As the site where the drug binds is found in all flu strains, the new drug is expected to be effective even against future flu strains."

"With millions of domestic birds currently infected with 'bird flu' globally, there are still concerns about its adaptation and potential to spread among humans, causing the next pandemic," she added.

Professor Steve Withers, University of British Columbia, has led the research team for the past seven years and said that although further studies are required to determine efficacy against a broader range of flu strains, the findings are extremely positive.

"Despite recent improvements in vaccine production, when a new strain of flu emerges it can take several months before vaccines are available to the public," he said. "This antiviral drug would play an important role as the first line of defence in modulating disease severity and in controlling a pandemic while vaccines are prepared."

Researchers estimate it will take up to seven years before the drug is released.

In order to infect cells, flu viruses bind to sugars on the cell surface. To be able to spread they need to remove these sugars. The new drug works by preventing the virus from removing sugars and blocking the virus from infecting more cells. It is hoped the drug will also be effective against future strains of the virus. According to the World Health Organisation, influenza kills some 500,000 people each year, up to 2500 of those in Australia. Costs to the Australian healthcare system are estimated to be more than \$85 million, with more than 1.5 million work days lost annually.

Dr Jenny McKimm-Breschkin comparing drugs in cells.



Crumbling bores “jeopardise nation’s water”

Fifteen thousand collapsing bores – and a half-billion-dollar repair bill – are endangering the future of Australia’s largest and most precious resource, its groundwater.

Australian homes, towns, cities, farmers and miners will rely increasingly on underground water as our population grows, surface water supplies dwindle and as droughts multiply under a warming climate, according to the Director of the National Centre for Groundwater Research and Training (NCGRT), Professor Craig Simmons.



Craig Simmons

“Groundwater accounts for about 90 per cent of Australia’s total freshwater reserves – only a fraction is in rivers, lakes and dams on the surface,” he says.

“Currently it supplies 30 per cent of our daily water needs – and will be called on a lot more in future. It’s vital for water supplies, agriculture, industry, mining and the environment.”

Australia does not have a clear idea exactly how much groundwater there is, how rapidly it is recharged or how quickly it is being depleted, Professor Simmons says. What we do know is based on data largely supplied by 23,000 monitoring bores spread across the continent, more than two-thirds of which are now falling into disrepair.

Late last year a report by the National Water Commission (NWC) found that 68 per cent of the 23,000 monitoring bores were more than 20 years old and at, or near, the end of their useful working lives. The current replacement cost of inoperative monitoring sites was estimated at \$318 million, rising to over half a billion dollars if governments continued to ignore the problem, the NWC report indicated.

Professor Simmons says there has been a steady increase in use of groundwater by Australian cities, towns and industries over the past 20 years, especially during the Millennium Drought.

“If we are unable to monitor what is going into or being taken out of our aquifers and how groundwater levels are changing, then some communities or industries may find they run out of water without warning.”

Groundwater is an important water supply in many remote and rural regions but urban groundwater use is expected to grow. Professor Simmons says that although only Perth among Australia’s major cities relies extensively on groundwater, most were now starting to think about how groundwater might augment water supplies as their populations grew, surface resources became strained and the cost of building dams became prohibitive.

“However, it is no good planning to use groundwater if you don’t know how much you’ve got, or its rate of use and recharge.”

Another dimension of the issue is that, because most of the water in Australia’s rivers is actually groundwater that has trickled in from underneath and the sides, understanding the groundwater cycle is also essential for managing major river systems and keeping them in good health, as is the case in the Murray–Darling Basin.

“We’re seeing more and more disputes over groundwater, between

farmers and coal-seam gas miners for example – these are an indication that Australia’s total water supplies are becoming tight and under pressure and the basis for public concern. We simply have to have a better handle on the national water balance, surface and sub-surface, how groundwater systems work and their role in environmental water flows and other pressing groundwater related processes, such as mining and coal seam gas.”

Professor Simmons says that, despite nationwide complacency since the breaking of the last drought, “the next drought is already on the way”. The past 200 years have taught us major droughts can be expected several times a century.

“It’s essential that as Australians, living in a dry continent, we don’t get taken by surprise by the next drought – or the ones that come after it. Part of our strategy for avoiding severe stress on domestic water, the food supply and our native landscape is to monitor and measure underground water.”

‘HOLLOW DROPS’ SHOWER HALVES WATER USE

A new shower nozzle that uses up to 50 per cent less water while maintaining the sensation of full pressure could provide Australians with guilt-free showers – simply by adding air.

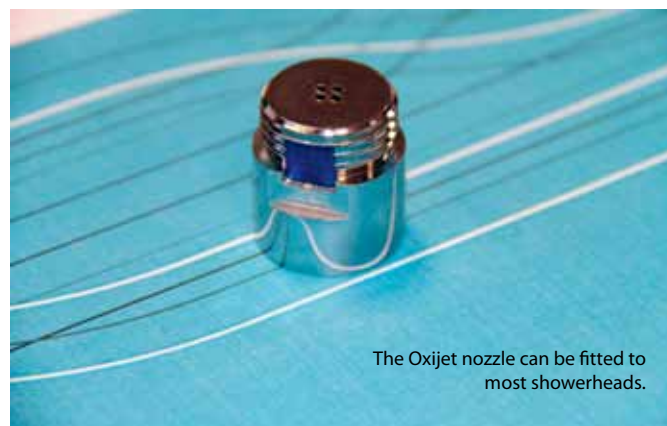
Oxijet could provide a cost-effective way to reduce household water consumption without affecting comfort. It can be fitted to most existing showerheads and is accredited by the Australian Watermark and Water Efficiency and Labelling Standards. It is now available for purchase in Australia.

Dr Jie Wu, a fluids specialist at CSIRO, said the Oxijet nozzle developed by New Zealand company Felton in collaboration with CSIRO, felt just as wet and strong as a full-flow shower, but used much less water, and differed from traditional ‘low flow’ devices.

“Traditional flow restrictors reduce flow and pressure, whereas Oxijet uses the flow energy to draw air into the water stream, making the water droplets hollow,” Dr Wu said. “This expands the volume of the shower stream, meaning you can save the same amount of water, while still enjoying your shower.”

The device was recently trialled by Novotel Northbeach in Wollongong and is planned for installation throughout the hotel.

“With over 200 rooms we go through over 10 million litres of water per year, so any saving we can make is very important. We’ve found our customers prefer Oxijet over other low flow showerheads, because it gives the illusion of full water pressure,” Mr Walter Immoos, General Manager of Novotel Northbeach said.



The Oxijet nozzle can be fitted to most showerheads.

Smart technology to predict water pipe failure

NICTA, Australia's leading information and communications technology (ICT) R&D organisation, has joined forces with Sydney Water to improve assessment of water pipes using technology that forecasts potential breakages in the system.

Australia's critical water mains break on average 7000 times a year due to age, material, soil type and other factors. Under the agreement with Sydney Water, NICTA's machine learning capabilities will be used to more accurately identify which pipes are at risk of failure, potentially saving Australia's water utilities and the community \$700 million a year in reactive repairs and maintenance.

"NICTA's technology was trialled in Wollongong and was able to accurately predict breaks in the following year with twice the precision of the existing technology," said Rob Fitzpatrick, Director, Infrastructure, Transport and Logistics at NICTA.

"NICTA is applying advanced machine learning techniques to pipe failure data from Sydney Water. We have been working together to develop a system that will reduce the inconvenience and expense incurred by water pipe breakages," Mr Fitzpatrick said.

"All water utilities with buried water pipes are faced with the issue of finding pipes that are at high-risk of failure before they fail and result in significant disruptions to the community. To do this we need accurate models to identify high-risk pipes which can cope with the differences in age, pipe material, environmental conditions and urbanisation," said Kevin Young, Managing Director of Sydney Water.

"We need smart technology to help provide answers. NICTA's approach is innovative and has the potential to have worldwide impact in pipe condition assessment. We have introduced the approach to our international colleagues, who are keenly watching the outcomes."

Dr Fang Chen, NICTA's Technical Lead on the project, said the approach could also be applied to other infrastructure failure prediction, such as bridges.

"This is the latest example of NICTA working with industry to develop the ICT for smart infrastructure that will drive Australia's future productivity," said Hugh Durrant-Whyte FRS FAA FTSE, CEO of NICTA.

Sydney Water provides drinking water, recycled water, wastewater and some stormwater services to more than four million people in the Sydney, Blue Mountains and Illawarra regions. Drinking water is sourced from a network of dams managed by the Sydney Catchment Authority, then treated and delivered to customers' homes and businesses by Sydney Water.

URBAN AUSTRALIANS MORE WATER-WISE

A new survey has shown that the majority of city-based Australians (96 per cent) took steps to use less water in 2012. The survey also found the number of people who considered the water situation serious across Australia's cities had increased for the first time since 2006.

The 'Attitudes to water efficiency' Newspoll survey was undertaken at the end of 2012 for Smart Approved WaterMark, Australia's label for products and services that save water. Over 700 adults aged 18 and over were interviewed in Sydney, Melbourne, Brisbane, Adelaide and Perth.

The CEO of Smart Approved WaterMark, Julian Gray, says: "Australians have a very strong emotional attachment to water as seen in the survey

with a staggering percentage of people actively saving water around the home."

Shorter showers and changing watering habits in the garden were the two most common activities undertaken, with just under 80 per cent of people reducing water use this way, and 64 per cent of people interviewed stopped washing the car or boat and 54 per cent retrofitted showers, taps or toilets through a government or utility program.

Greywater use around the home and garden was another popular water conservation activity, the survey showed, with 43 per cent of urban Australians recycling or collecting rainwater. Some 38 per cent of people have bought a water-efficient product or appliance using a rebate from government or utility and 18 per cent of people say they have reduced their water use around the pool.

The survey also revealed generational trends in attitudes with Generation X the most concerned (93 per cent), followed by Generation Y (80 per cent), with Baby Boomers the least concerned (76 per cent).

Smart Approved WaterMark is Australia's label for products and services that save water. The scheme was established by the Australian Water Association, Irrigation Australia, the Nursery & Garden Industry Australia, and Water Services Association of Australia. The scheme is supported by Australian governments.

TREES NEED MORE GROUNDWATER

Researchers at the National Centre for Groundwater Research and Training (NCGRT) have found eucalypts, melaleucas, acacias and other Australian native trees drink much more groundwater than previously thought, which may impact on how much water we can pump out of our aquifers.

"Past models used to predict groundwater resources have neglected how these trees can use special pathways to harness groundwater, especially during long dry periods, says Parikshit Verma of NCGRT and Monash University.

"Our new model shows that during dry periods, the native plants can use nearly 50 per cent more groundwater through these pathways than was allowed for in the past. It's critical that we now re-evaluate how much groundwater we allocate for our own uses, as over-extraction can kill the plants and their surrounding landscapes," Mr Verma says.

Apart from growing dense root networks to absorb surface water, they also develop deep roots, up to 10 metres long. By having roots in several soil areas, the trees are assured of a drink even during dry periods.

"Their deep, thick roots compensate for the lack of surface water by taking up groundwater from lower soil layers. The tree then releases this into the surface soils, so it can be used the following day."

"Now we know our landscapes are much more dependent on groundwater than previously thought, Australians will need to allocate more of our bore and well water to maintaining them. This means being more sparing in our use of bore water, especially during drought."



Every bucket counts – part of the Smart Approved WaterMark campaign.

400 activities in science engagement reported

The audit funded by the Federal Government's Inspiring Australia program has identified more than 400 activities in Australia designed to engage people with science.

The online survey, from July to September 2012, gathered activities from universities, science centres, museums, zoos, CSIRO, businesses and private individuals related to engagement activities held between January 2011 and June 2013. It aimed to gain a national picture of science-engagement activities so that people involved in science communication could access the data on research trends, discover new ideas, look for complementary projects and avoid duplication of activities.

The majority of activities:

- target large groups of school-aged children and the general public, and are less likely to target specific groups such as farmers, businesses and community groups;
- involve presentations, seminars, lectures, educational activities or visits to schools or regional communities;
- are about biological and environmental sciences more than about information and computing, engineering or mathematical sciences;
- involve people learning from watching, listening or viewing lectures, media or exhibits and, to a lesser extent, asking questions (and rarely about group problem-solving, consulting or sharing views);
- commonly use websites, face-to-face interactions, social media, newsletters and traditional media as tools of engagement;
- are about ongoing science, and to a lesser extent about completed science (and rarely about gaining funding or support before or during the science, or about shaping the science question); and
- focus on "understanding of the natural and human-made world" (rarely on "institutional priority or public policy change related to science and technology").

Econnect Communication worked with Bridge8 and the Australian Science Communicators on this 2012 audit. This team is also working on a new project to make the data accessible via an interactive website, expected to be ready by May.

NICTA AND INFOSYS COLLABORATE

NICTA and global business consulting and technology services firm Infosys have signed a joint research collaboration agreement to tackle the hard technology problems facing businesses today.

Potentially, the collaboration could see ageing technology systems readily modernised for the cloud; logistics departments could find faster, greener transport routes; and 'agile' techniques previously used for software development could be adapted to accelerate the definition and solution of business challenges.

"Innovation across borders is essential to accelerate the pace of world prosperity," said Mr N.R. Narayana Murthy, co-founder and Chairman Emeritus of Infosys. Mr Murthy has been a member of NICTA's International Business Advisory Group (IBAG) since 2005. "Having watched NICTA grow from start-up to one of the world's leading research organisations, I expect this to be a formidable partnership."

The program is intended to include joint research, PhD student internship and professional exchange programs, as well as commercialisation of relevant IP over the next five years.

"NICTA is proud to work with a world-renowned business and technology services company like Infosys. This is proof NICTA has emerged as a powerhouse in ICT research," said NICTA CEO Dr Hugh Durrant-Whyte FRS FAA FTSE.

Early collaboration is likely to focus on engineering challenges such as:

- 'platformising' software applications;
- improving methodologies used to define business problems;
- cloud resiliency and privacy preserving techniques; and
- optimisation in infrastructure, disaster management, logistics and smart grids to take advantage of Big Data and other emerging technologies.

3D PRINTING HELPS TRACK BIG FISH

CSIRO scientists are using 3D printing to build a new generation of hi-tech fish tags made of titanium to track big fish such as marlin, tuna, swordfish, trevally and sharks for longer periods. The tags are being printed at CSIRO's 3D printing facility, Lab 22, in Melbourne, and shipped to Tasmania to be trialled by marine scientists.

Titanium is strong, resists the salty corrosiveness of the marine environment, and is biocompatible (non-toxic to living tissues); 3D printing enables rapid manufacture of multiple design variations which can be tested simultaneously.

CSIRO's 3D printing facility prints metal items layer by layer out of fused metal powder. Had the scientists been using conventional tags, which are machined out of metal blocks, it would have taken a couple of months to design, manufacture and receive the new designs for testing.

"Using our Arcam 3D printing machine, we've been able to redesign and make a series of modified tags within a week," says John Barnes, Titanium Technologies Theme Leader, Future Manufacturing Flagship. "When our marine science colleagues asked us to help build a better fish tag, we were able to send them new prototypes before their next trip to sea."

"The fast turnaround speeds up the design process – it's very easy to incorporate amendments to designs – 3D printing enables very fast testing of new product designs, which is why it's so attractive to manufacturers wanting to trial new products."

Scientists from a number of agencies, including CSIRO Marine and Atmospheric Research, use fish tags to track the movements of individual marine species and increase understanding of their behaviour.

Medical implants such as dental implants and hip joints are made of biocompatible titanium with a surface texturing that speeds healing and tissue attachment after implantation. Scientists hope that a similar rough surface will help the tag to stay in fish longer.

CSIRO's Lab 22 3D printing facility was established in October 2012 and has been used to manufacture a range of prototype products including biomedical implants, automotive, chemical processing and aerospace parts.



The latest fish tag.

Is liquid air the missing link in energy storage?

The role of the electricity distribution network and its flexibility is an essential component in the delivery and overall cost and viability of any storage scheme.



By Richard Williams
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I have never quite got to the bottom of why greater value is not placed on the latent energy assets that Australia has in its solar and nuclear resources.

Australia is not alone in coming to experience that there is a vital missing link – the inability to store energy – that keeps a divide between the aspirations of being able to use renewable resources and the practicalities of renewables' use in future energy generation and supply systems.

The concept of electrical and thermal storage is mentioned in the 2012 Energy White Paper 2012, however it is somewhat surprising that the issue is not highlighted as an area needing strategic intervention alongside the demand and supply management measures.

With renewable sources, energy is often created in the wrong place at the wrong time and it becomes difficult to utilise it. Examples would be wind, wave and solar energy. A key question is what

technologies are available to capture the energy in a form that can be used and to do this in a highly cost-efficient manner?

In the UK efforts have been made to raise government's understanding of where the value of electrical and thermal energy storage may lie in a marketplace that is deregulated with separate bodies for generation, transmission and distribution. The situation in Australia has some resemblance, to the extent that Australian Climate Change legislation is driving de-carbonisation and this will shift the energy provision and create new markets. The public mind however is on cost, energy poverty, accessibility and security of supply.

However, the opportunities in the UK and Australia are very different, just as the energy generation mix is very different. In November the UK Chancellor announced that energy storage technology was indeed critical to the future UK economy and valued at £10 billion a year by 2050. This

value comes from understanding where the different energy storage technologies fit into the grid at generation, transmission and distribution segments. It's not simply a matter of providing storage capacity but seeing how a robust system can be configured to suit the changing energy mix and so minimise the cost of transmission investment as the demand for electrical power grows, due to electrification. UK Ministers have subsequently emphasised the need for energy storage research.

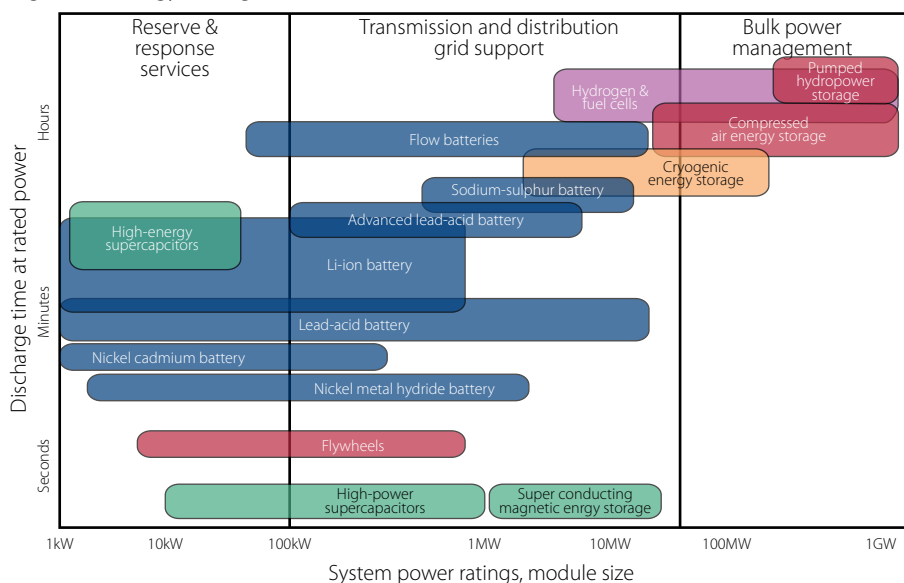
So what might energy storage mean for Australia – or perhaps, first, what it doesn't mean.

In my view it certainly should not mean filling the country with batteries for storing renewable energy. Batteries are vastly resource-intensive and demand re-use in ways that business models have not been able yet to accommodate. While there have been some extensive battery park trials for regional storage in China, the US and other energy constrained countries (for example, Chile) this does not appear to be a widespread option suited for Australia.

A range of energy storage methods is currently available and most of these have been reviewed recently. Figure 1 shows a summary based upon the scale of power rating and the call-down time, expressed here as a discharge time at rated power.

Clearly, different applications demand appropriate storage characteristics and a range of technologies are needed to suit the specific needs. Technologically speaking, energy can be stored in mechanical, electrical or chemical devices and in the form of heat. All are probably needed but, other than hydro-storage dams, there have been few examples at a significant scale. The need for flexibility in supply means that it is likely that several different types of storage may be needed since some can be switched

Figure 1 Energy storage methods



Key: Types of storage Hydrogen-related Mechanical Electrochemical Electrical Thermal

Table 1 Comparative energy storage cost estimates

Technology	Size range (MW)	Capital cost (\$/kW)	Capital cost (\$/kWh)	Efficiency (% round trip)	Geographical requirements	Use of advanced chemicals
Pumped hydro	280-530	2500-4300	420-430	76-85	Requires mountains	No
CAES (with gas firing)	180	960-1150	60-120	46-48	Requires caverns	No
NaS battery	< 50	3100-3300	520-550	68	None	Yes
Flow batteries	< 50	1450-1750	290-350	60	None	Yes
Highview Cryo Energy System	10-200	900-1900*	260-530*	50-80+	None	No

* Depending on cycling.

on quickly (batteries), whereas others require a few minutes before providing an energy supply (heat, hydroelectric).

The place of deployment of different technologies is likely to be at city, region, home and personal/domestic device level. Very large-scale storage capacity is likely to be associated with industrial operations or at points of generation and distribution. The role of the electricity distribution network and its flexibility is an essential component in the delivery and overall cost and viability of any storage scheme. Clearly, the point of deployment affects the grid demand and methods through which it may be controlled.

Conventional batteries of different types have their place but the societal need is pressing strongly for an alternative to batteries. This is not only driven by realisation of the cost, resource wastefulness, environmental impact and scarcity associated with rare earth components but also a growing public misgiving about safety. The number of battery-related safety incidents has been growing rapidly over the past few years, relating to vehicular and air transportation, computers, large-scale battery parks and wind/solar on-site storage locations.

There are alternatives. For example, in the UK there is a growing interest in the notion of cryogenic liquids. These are reported to be at a lower cost point and more likely to be suitable where solar energy can be used to drive compressors to compress air to liquid air (as cryogenic fluids). Liquid air is potentially an energy vector in itself and vaporisation of the liquid using low-grade waste heat makes for a very efficient system that then drives a generator.

The round-trip efficiency of these systems rivals batteries. These have now been demonstrated at a small scale –

with 350kW/2.5MWh scale for on-grid electrical storage and further developments to scale out to beyond 10MW underway. Systems of 100MW or more with GWhs of storage are deliverable using existing supply chains and components. Some comparisons of estimated costs for comparative storage systems have been mooted (Table 1).

Such systems offer a means for low-cost off-grid generation, to smooth power requirements (as demonstrated in arbitrage benefits in UK) and to provide security of supply by creating a national reserve.

Liquid air is also useable directly as a fuel and the first 'cars that run on air' are currently being evaluated and attracting significant attention. The concept of liquid air as an energy vector is based on the fact that Australia, as the UK, has an existing infrastructure to support early adoption. The technology derives from mature supply chain/components with

proven long life whose costs are known.

Liquid air storage is at low or atmospheric pressure, resulting in low-cost, above-ground, safe bulk tanks. There is no fuel combustion risk. There are no geological/geographical constraints to location of stores or distribution pathways. The energy density of liquid air compares favourably to other low-carbon competitors.

Finally, there is great synergy with other industrial processes, including use of waste heat and provision of cold. Further, there is the option of using liquid air as an energy vector to transport this stored energy around by road (as is currently done) or ship (as with LNG).

A major review of this opportunity is underway and this may have profound application in Australia if it turns out that liquid air can be used as a fuel. Meanwhile, the UK Energy and Climate Change Minister John

Cryogenic on-grid energy storage 2.5MW demonstration plant in Slough, UK.



Hayes believes that liquid air may offer some radical solution with real economic stimulus to the economy.

Putting a value on energy storage is difficult. The value lies in different places for different applications. A key reflection in approaching this with regard to solar is that the business model has a feedstock (sun) that is free and this means that arguments based purely on technical process efficiency and cross-comparisons to other process are not germane. Rather it is the benefit that needs to be quantified.

Australia will need to grasp these emerging concepts as new opportunities emerge to better utilise renewable energy and mitigate escalating infrastructure costs associated with energy supply and security. I am increasingly confident that the de-carbonisation drivers may open up significant new economic opportunities ahead.

This article is based on Professor Williams' presentation to an ATSE Energy Forum meeting in November 2012.

PROFESSOR RICHARD WILLIAMS OBE FEng FTSE is a Foreign Fellow of the Australian Academy of Technological Sciences and Engineering, professor at the University of Birmingham (UK) and honorary professor at the University of New South Wales. He is a co-author of the Royal Academy of Engineering and Chinese Academy of Sciences report into the future of energy storage technologies and policy. He is a Fellow of the Royal Academy of Engineering, an adviser to NetScientific Solutions and a member of the Liquid Air Association working group.

Funding boost for CSIRO UltraBattery

Cost-effective battery storage for residential and commercial renewable energy systems is a step closer following an Australian Government investment of \$480,000 to test a world-leading battery technology.

The Australian Renewable Energy Agency's (ARENA) Emerging Renewables Program will put nearly \$500,000 in project funding into Ecoult, a CSIRO spin-off company, to optimise CSIRO's UltraBattery technology.

The \$1.16 million project aims to optimise the UltraBattery technology for use in a range of settings, including residential locations with a high number of household solar installations; in remote areas not connected to the national electricity grid; and in hybrid diesel systems.

Applying the technology to hybrid diesel systems will help to improve fuel efficiencies, while in remote areas it will help provide electricity to communities when renewable energy sources are not available.

"In residential areas with a large volume of rooftop solar photovoltaics, or in off-grid and remote communities that are trying to displace diesel through renewables, battery technology will be crucial to maximising electricity from renewable energy resources," said former Resources and Energy Minister Martin Ferguson.

"One of the benefits of CSIRO's UltraBattery technology is its suitability for managing energy intermittencies, smoothing power from irregular sources and shifting energy availability over time to ensure more regular availability.

"That's why the Australian Government, through ARENA, will be investing in a 30-month project using the UltraBattery technology to determine whether it can lower operating and storage costs by conducting testing on a storage pilot at CSIRO's Newcastle facilities.

"Testing the UltraBattery technology for both off-grid and distributed technology environments will allow us to learn how we can reduce power fluctuations, which can otherwise act as a barrier to connecting additional solar installations to the electricity grid."

SOLAR COUPLE WIN INNOVATION AWARD

A solar 'power' couple who trained at the University of NSW have been honoured with an award recognising visionary Australian citizens living and working abroad.

Dr Jianhua Zhao and his wife Dr Aihua Wang were joint recipients of an Advance Global Australia Award for contributions to the field of clean technology. The pair also won a special Australia in the Asian Century Honour.

"Jianhua and Aihua were excellent students and staff members here at UNSW, and prolific researchers," said Scientia Professor Martin Green AM FAA FTSE, Director of the ARC Photovoltaics Centre of Excellence.

"They took us to the position where we can now make the most efficient cells in the world and nobody yet has been able to catch up. They are both well respected internationally and have played an influential role in establishing China as a major producer of solar power and PV technology."

Dr Zhao, who completed his PhD in electrical engineering at UNSW under Professor Green in 1989, was affiliated with the university as a lecturer, researcher and associate professor until 2006. In 2004, he co-founded the Chinese solar cell manufacturing company China Sunergy, where he is now Chief Technology Officer and Director. Dr Wang, who also completed her PhD and worked at UNSW for more than a decade, is the company's Vice-President of R&D.

In 1999 the pair developed the high-efficiency crystallised Silicon

PERL cell and set a new record, demonstrating 25 per cent energy conversion efficiency – one of several records they set while at UNSW.



Martin Green (centre) with Jianhua Zhao and Aihua Wang.



WAGCOE Director Professor Klaus Regenauer-Lieb discusses the CSIRO Geothermal Project with project officer Jacqui Cook at the ARRC site in Perth.

Geothermal to cool supercomputer

The development of a renewable system for cooling Australia's largest supercomputer is a step closer, following the start of an innovative geothermal energy project in Perth.

In what will be an Australian first, the CSIRO Geothermal Project will deliver a novel solution for cooling the Pawsey Centre supercomputer, an \$80 million facility currently under construction in Kensington, in Perth.

"The system is known as groundwater cooling and works by pumping cool water from a depth of around 100 metres through an above-ground heat exchanger to cool the supercomputer, then reinjecting the water underground again," said CSIRO's project director Steve Harvey.

"Although the water returned to the aquifer is a few degrees warmer than the surrounds, the groundwater cooling system is engineered to prevent negative impacts to the surrounding environment."

With zero net use of groundwater, the system is also environmentally friendly. CSIRO estimates that using groundwater cooling to cool the Pawsey Centre supercomputer will save approximately 38.5 million litres of water every year, in comparison to using conventional cooling towers. That's enough to fill more than 150 Olympic-sized swimming pools. If deployed more widely, the technology also has the potential to replace cooling towers in buildings all over Perth.

Drilling work to implement the groundwater cooling system has recently commenced at the Australian Resources Research Centre (ARRC) in Kensington's Technology Park – the same site that houses the Pawsey Centre supercomputer. The challenge of cooling the new petascale computing system – which will provide expertise to support the world's largest-ever radio telescope (the Square Kilometre Array) and other high-end science – was one of the driving forces behind the CSIRO Geothermal Project.

As well as using a shallow geothermal solution to cool the supercomputer, the CSIRO Geothermal Project will also investigate a potentially deeper geothermal energy resource located beneath the ARRC site by constructing a three-kilometre deep exploration well later this year.

The project is one of the achievements of the Western Australian Geothermal Centre of Excellence (WAGCOE), which concluded in

February. Established in 2009 with funding support of \$2.3 million from the WA Government, WAGCOE brought researchers, industry, investors and government agencies together with the shared vision of creating zero-emission geothermal cities. Partner organisations were The University of Western Australia, CSIRO and Curtin University.

Among WAGCOE's achievements was the development of a 3-D computer model illustrating a comprehensive geological assessment of the entire Perth Basin, which will act as a template for future geothermal activities in the region.

The centre was also instrumental in securing \$20 million of Australian Government funding for the CSIRO Geothermal Project.

\$10 MILLION FOR BIOFUELS

The Australian Government will invest \$9.8 million in two projects through the Australian Renewable Energy Agency's (ARENA) Advanced Biofuels Investment Readiness Program.

The former Minister for Resources and Energy, Martin Ferguson, announced \$5.4 million for Licella Pty Ltd, to assess the feasibility of constructing its first pre-commercial biofuel plant, and \$4.4 million for Muradel Pty Ltd, to demonstrate its algal biofuel technology.

Licella, which opened its commercial demonstration plant in 2011, will use the \$5.4 million to undertake an \$8.2 million feasibility study into the construction of its first pre-commercial biofuels plant. If constructed, it is estimated that the plant could produce 125,000 barrels of bio-crude per year, which could be used as a drop-in fuel for the aviation industry.

Muradel will use the \$4.4 million investment in a \$10.7 million project near Whyalla, South Australia, up-scaling its marine algal production and harvesting technology – from pilot to demonstration size. The technology has the potential to become sustainable 'green crude' for the existing petroleum industry and to provide fuel for aviation.

Both projects are expected to be completed by the end of 2014.

WAVE POWER TRIAL FOR DESALINATION

The Australian Government will support Western Australia's Carnegie Wave Energy Ltd in trialling a project to power desalination plants with wave energy.

This world-first project will use the power of ocean waves to directly drive high-pressure desalination pumps at a pilot-scale desalination plant, substantially reducing emissions and electricity consumption.

A grant of \$1.27 million from the Clean Technology Innovation Program will support the \$2.5 million project. Carnegie already supplies power to major naval base HMAS Stirling through its Wave Energy Project at Garden Island, near Perth. The company will use its existing CETO technology to drive the desalination pumps on the island to make seawater drinkable.

Carnegie Wave Energy Chief Operating Officer Greg Allen said the Company's CETO system deployed fully submerged buoys that are tethered to pump units on the seabed.

"These buoys move with the motion of passing waves, pressurising water that is delivered onshore to drive the hydraulic motor and pumping system for the desalination plants," Mr Allen said.

"Together, the wave-powered power station and desalination plant on Garden Island will produce power and clean, drinkable water for the Navy. The Garden Island site will enable us to demonstrate the technology to organisations interested in developing wave-powered power stations and desalination plants throughout the world."



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APRIL 2013

John Grill named to head National Precincts Board

The Australian Government has appointed Mr John Grill FTSE as the Chair of the National Precincts Board, which will drive the Government's \$504.5 million initiative to establish up to 10 Industry Innovation Precincts.

The Precincts initiative is part of the Government's Industry and Innovation Statement, *A Plan for Australian Jobs*, which aims to forge closer links between business and the research sector and help Australian industry to become more productive and competitive.

In addition to Mr Grill's appointment, the Government has announced the other nine members of the National Precincts Board and the Chairs of the first two Precincts for the Manufacturing and Food sectors.

"Mr Grill is exceptionally qualified to chair the National Precincts Board," said the Minister for Industry and Innovation, Greg Combet.

"As an engineer and former Chief Executive of international resources and energy company WorleyParsons, his leadership skills and experience in creating highly successful businesses will equip him well for this important position.

John Grill



"Mr Grill has wide respect across the industry and research sectors and will work with all stakeholders to ensure Industry Innovation Precincts deliver results for Australian business and Australian workers."

The National Precinct Board members have been drawn from the business and research communities. They will provide expertise and advice to ensure the Precincts initiative is effective and delivers significant outcomes.

"The Government will complement the Precincts with an online Industry Innovation Network that will allow businesses to take part in Precinct activities and gain access to technology, knowledge, business services and partnerships, regardless of their location," Mr Combet said.

Mr Grill is the former Chief Executive of international resources and energy company WorleyParsons and now its Non-executive Chair. Under his leadership, WorleyParsons has become a global enterprise providing specialist design and project management services in the mechanical, electrical, chemical, instrumentation, civil, structural, environmental, geotechnical and coastal marine fields.

He began his career with Esso Australia and in 1971 established Wholohan, Grill and Partners as a specialised engineering practice in the oil and gas industry. His firm acquired the US company Worley Engineering (Australia) in 1987. Following group restructuring, in 2002 Worley Group Ltd listed on the Australian Stock Exchange.

In 2004, Worley Group acquired Parsons E&C Corporation, a US-based global project services company, and changed its name to WorleyParsons Ltd.

Mr Grill is known for his personal expertise in every aspect of project delivery for projects in the resources and energy industries. He has been directly involved with most of the major clients of WorleyParsons and was closely involved at board level with the group's joint ventures.

He was awarded an honorary doctorate by The University of Sydney in 2010 in recognition of his contribution to the engineering profession. He is also on the board of Neuroscience Research Australia.

Board members of the National Precincts Board include Dr Megan Clark FTSE, CEO of CSIRO, and Professor Ian Chubb AC, Australia's Chief Scientist.

MARY O'KANE JOINS IP COUNCIL

Professor Mary O'Kane FTSE, NSW Chief Scientist and Engineer, is one of four new appointments to the Advisory Council on Intellectual Property (ACIP), an independent body that provides strategic advice and direction to the Government on registrable intellectual property.

Her appointment noted Professor O'Kane's "comprehensive expertise advising governments, universities and the private sector on innovation, research, education and development".

Since its establishment in 1994, ACIP has completed 14 reviews into Australia's IP system. It is currently reviewing the Innovation Patent System and the Designs System.

Announcing the appointments, Industry and Innovation Minister Greg Combet said they would provide further rigour and strategic advice to the Government's decisions on intellectual property.

The other appointees are: Professor Mark Davison of Monash University's Law Faculty, who has more than 20 years' expertise in the IP arena as a lecturer, researcher and legal practitioner; Associate Professor Kimberlee Weatherall, who teaches and researches IP law at Sydney Law School; and Mr Greg Munt, a registered patent and trademark attorney involved in intellectual property for nearly 30 years, with significant experience in Asian IP.



Mary O'Kane

Seven Fellows win 2013 Australia Day honours

Seven Fellows of the Academy were recognised in the Australia Day Honours list, headed by **Mr Clive Weeks AO FTSE**, former Chair of GHD.

Mr Weeks was recognised for distinguished service to engineering through leadership roles of key civil works projects and through contributions to professional and educational organisations.

Professor William Roy Jackson AM FTSE, from Monash University, was recognised for significant service to science in the field of organic chemistry as an educator and researcher.



Clive Weeks

The former CEO of AIRG, **Dr Errol McGarry AM FTSE**, was recognised for significant service to science and technology, particularly through research and development in the field of chemistry.

Monash University's **Emeritus Professor Owen Potter AM FTSE** was recognised for significant service to chemical engineering through leadership in the areas of education, research and development, and to the Catholic Church.

CSIRO Honorary Research Fellow **Dr David Rand AM FTSE** was honoured for significant services to science and technological development in the area of energy storage, particularly rechargeable batteries.

Mr Graham Spurling AM FTSE, former CEO of Mitsubishi Motors, was honoured for significant service to business and to the community of South Australia.

Dr Bruce Walker AM FTSE, Director of Desert Knowledge Australia, was honoured for significant service to the indigenous communities of remote Australia and the Northern Territory, and to the sport of cricket.

Mr Weeks (Fellow since 2008) is a former Chairman of GHD (2003–08), Chief Executive Officer (2002–03), Director (1992–2008) and Manager, Victorian and Northern Territory Operations (1972–92). He is a Board Member

of the Regional Rail Link Authority and the Monash University Engineering Foundation; Consultant to the Melbourne CityLink Authority/Linking Melbourne Authority; and won the Sir John Monash Medal for Services to the Monash Engineering Faculty in 2011. He is President of the Rotary Club of Melbourne, a Fellow of Engineers Australia and the Institute of Company Directors and a member of the Australian Water Association.

Professor Jackson (1990) has been Professor of Organic Chemistry, Monash University, since 1973 and a Sir John Monash Distinguished Professor since 1995. He was Founding Director of the ARC Special Research Centre for Green Chemistry (2000–02); President of the Royal Australian Institute of Chemistry (1999–2000); and has been a Fellow of the Australian Institute of Energy since 1982.

Dr McGarry (2001), a Fellow of the Royal Australian Chemical Institute, was Chief Executive Officer, Australasian Industrial Research Group (2005–08); President (1999 and 2002); and Founding Member, Industry Advisory Group, Faculty of Science, University of Melbourne (2000–10). His industry career included more than 20 years with ICI in Britain and Australia, followed by three years with Huntsman Corporation (1999–2002).

Drew Clarke to head DBCDE

After almost three years as Secretary of the Department of Resources, Energy and Tourism (RET), Mr Drew Clarke PSM FTSE has been appointed the new Secretary of the Department of Broadband, Communications and the Digital Economy.

Mr Clarke was appointed Secretary of RET in April 2010, following his time as Deputy Secretary. A former surveyor who has worked in Australia and Antarctica, he joined the energy area of the then Department of Industry, Tourism and Resources in 2002 and moved to the newly created RET in December 2007.

In a warm tribute, Mr Martin Ferguson, former Minister for Resources and Energy, said Mr Clarke's contributions to public policy had been impressive, including his work in spatial data, the establishment of the National Offshore Petroleum Safety and Environmental Management Authority, and driving an economic agenda for the tourism industry.

Of particular significance, Mr Ferguson said, was his work in energy policy, where he had been at the helm of the national energy market reform agenda for more than a decade. Mr Clarke has also been a major contributor to the International Energy Agency, serving on its Governing Board, and has been instrumental in clean energy technology

development and energy-related climate change policy.

"I thank Drew for the leadership he has brought to the Department and the support he has given me and my office during his time as Secretary," Mr Ferguson said.

"His honest advice and dedication to pursuing a challenging policy agenda have been invaluable to me and, I believe, the nation. I know that the staff of RET will greatly miss his expertise and steady hand, as will I.

"I congratulate Drew on his new role, where I know from personal experience he will be an immense asset."

Drew Clarke





Errol McGarry

Professor Potter (1983) was Chair, Department of Chemical Engineering, Monash University (1964–90) and Head, Department of Chemical Engineering, The University of Melbourne (1960–64). He has been Emeritus Professor of Chemical Engineering at Monash since 1991. He was co-founder and Chairman of the Victorian Branch of the Institution of Chemical Engineers (1965–67 and 1975–76). He is a Fellow of Engineers Australia, the Institution of Chemical Engineers and the Royal Australian Chemical Institute.

Dr Rand (1998) was Chief Research Scientist and Scientific Adviser on hydrogen and renewable energy, Division of Energy Technology, CSIRO (1994–2008) and has been a CSIRO Honorary Fellow since 2008. He was Founder and Head, Battery Research Group (1977–2002); Manager, Novel Battery Technologies (2001–02); and Research



David Rand

Scientist (1969–93). He Vice President and a founding member of the Australian Association for Hydrogen Energy; has served on a number of international organisations and his work has been published in the form of 164 research papers, 188 technical reports and seven patents. His research has been recognised both nationally and internationally by the award of the Faraday Medal of the Royal Society of Chemistry (UK), the UNESCO Gaston Planté Medal by the Bulgarian Academy of Sciences, the CSIRO Chairman's Medal, the Australian Centenary Medal, the Stokes Medal of the Royal Australian Chemical Institute and the CSIRO Medal for Research Achievement.

Mr Spurling (1987) was Managing Director, Mitsubishi Motors Australia (1980–87) and President, Federal Chamber of Automotive Industries (1983–84). He is Chairman of Phoenix Copper and Bundaleer Wines, and was a Director of Dexion Ltd (2005–11). He



Bruce Walker

is a Fellow of Engineers Australia and the Institute of Company Directors and has served on many community, church and industry bodies in South Australia and as an Army Reserve officer.

Dr Walker (2008) has a long history of service to the community of central Australia. He has been a Director of Desert Knowledge Australia since 2006 and Chief Executive Officer and Founder, Centre for Appropriate Technology (1980–2010). He has been a Director of the National Australia Day Council since 2006; Chairman of the NT Research and Innovation Board since 2010; Chairman, John Flynn Uniting Church Council, Alice Springs (1984–90 and 2009–12); Chairman, Central Land Council Audit and Risk Committee, since 2012; Director, Remote Focus Project (2010–12); Project Director, Desert Peoples Centre (2004–10); and President, Northern Territory Cricket Association, since 2002.

Gus Guthrie: academic leader and hospital clown

Former Vice Chancellor and President of the University of Technology, Sydney, Professor David Roy 'Gus' Guthrie AM FTSE has died in Nambour, on Queensland's Sunshine Coast, aged 78.

Born in England, he graduated in chemistry in 1955 from the University of London, then took a PhD in organic chemistry in 1958 and a DSc in 1968 at the same university.

He started his career as a researcher in the UK cotton industry in 1958 followed by spells as a lecturer and Reader in organic chemistry at the University of Leicester (1960–63) and University of Sussex (1963–73), and consultancy with ICI and Schering Corporation.

He came to Australia in 1973 and spent eight years at Griffith University as first Chair of the School of Science and Foundation Professor of Chemistry, then as Pro-Vice Chancellor.

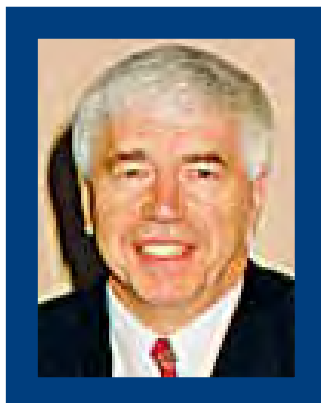
Professor Guthrie returned to England in 1982 as tutor at the Open University, then worked as Secretary General of the Royal Society of Chemistry (1982–86) before moving to Australia again in 1986 as President

of the NSW Institute of Technology (predecessor of the UTS) and then as Vice Chancellor and President of UTS (1988–96).

He held honorary doctorates from Griffith University, UTS and Humberstone University and was a Fellow of the Royal Society of Chemistry, the Royal Australian Chemical Institute, the Royal Society of Arts, the Australian Institute of Management and the Australian Institute of Company Directors.

In retirement he lived in the Sunshine Coast hinterland and on the coast and served as chairman of the Buderim Foundation, treasurer of the Kiel Mountain Rural Fire Brigade, and member of Buderim Probus Club and the Headland Buderim Croquet Club.

He was a founding member of Coastal Caring Clowns and as Charlie the Clown brought smiles to many sick and aged people in Sunshine Coast hospitals and nursing homes.



Gus Guthrie

Don Gibson: privileged, principled and a “stubborn critter”

Dr Don Gibson FTSE, who died in Melbourne recently, was widely known and respected at CSIRO (where he served for 28 years), in associated businesses and in the Academy, of which he was a Fellow for two decades.

His resilience in dealing with a long-term illness was notable and in the weeks leading to his death he was in touch with a number of Fellows.

Former Vice President Professor John Simmons AM FTSE was a friend from their days at The University of Sydney. His comments are indicative of Don Gibson's character.

“I met Don in 1957 at The University of Sydney. He was an outstanding student but he found time between classes to meet Penny and begin a 50-year partnership. He was kept going at the end by his determination to speak at Penny's 70th birthday. He just made it. He was always a stubborn critter.

“I visited Don just three weeks before he died. His attitude and peace of mind were extraordinary and inspirational. We spent the few hours mostly laughing.”

Donald Charles Gibson was born in Sydney in 1940 and educated at the Killara Preparatory School and at Sydney Grammar

School. He graduated from The University of Sydney BSc with majors in Physics and Mathematics in 1961 and BE with First Class Honours in Mechanical Engineering in 1963.

He came under the influence of the late Professor Tom Fink AO CB CBE FTSE, a Foundation Fellow of the Academy and one-time Chief Defence Scientist, who was the Professor of Mechanical Engineering.

John Simmons recalls: “Tom Fink ... had a huge influence on Don (and me). He helped Don along the road to a PhD at Cambridge University and was a sounding board for Don through his career. I know this because when I visited Don for the last time, his huge respect and fondness for Tom Fink almost dominated our conversation.

“Through his fluid mechanics lectures, Tom Fink had introduced us to the beauty of vortices in fluid flow. This became a life-long passion for Don. A decade ago he sent all his friends some photos of vortices he had observed in a stream as he hiked through a national park.”



Don Gibson

In October 1963 Don went to Churchill College, Cambridge, on a Gulbenkian Research Studentship. In October 1966 after his Gulbenkian Scholarship had ended he was awarded a studentship from the CSIRO Division of Mechanical Engineering. He became a Research Engineer in October 1967, Senior Research

Scientist in 1970 and Principal Research Scientist in 1977.

When a Division of Energy Technology was formed from the Division of Mechanical Engineering, Don was appointed the Acting Chief (1981) and subsequently Chief of the new Division.

In this new capacity, Don promoted, in particular, the development of new directions related to energy conservation. The Division initiated research in combustion fluid mechanics, thermal performance of buildings, novel heat exchanger technologies and optimisation of traffic control to reduce fuel consumption and emissions.

In 1987 he became Chief of the Division

ENVIRONMENTAL AWARD TO JOHN FRENEY

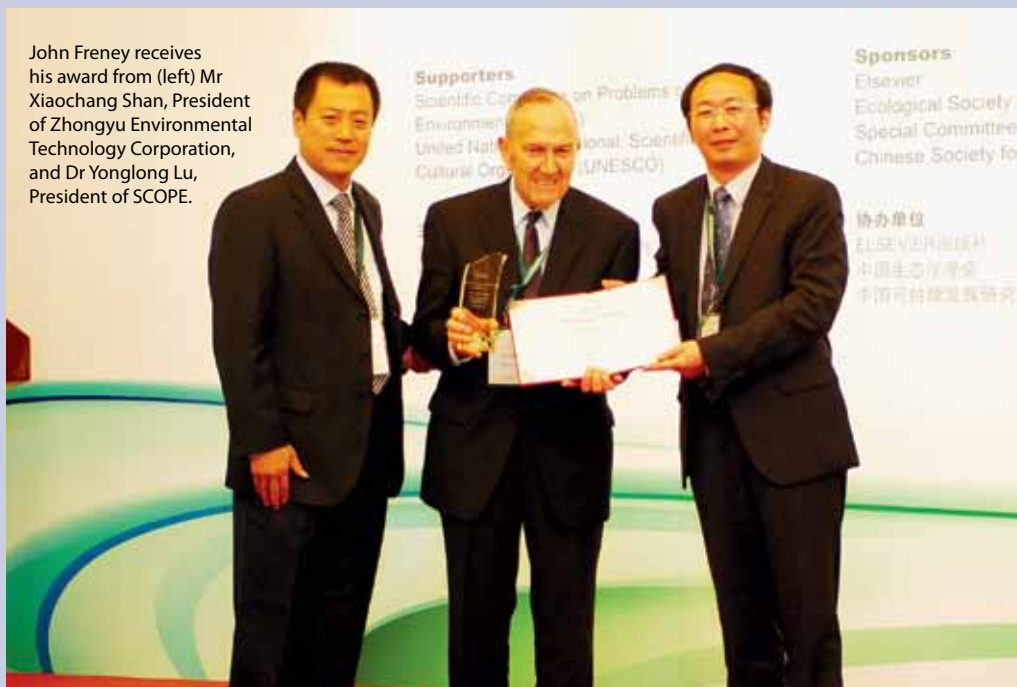
Dr John Freney FTSE, from CSIRO Plant Industry, was presented with a Lifetime Achievements Award at the presentation of the SCOPE–Zhongyu Environmental Awards for 2012, in Taiyuan, Shanxi Province, China, last October.

The SCOPE–Zhongyu Environmental Awards recognise scientists who have made significant contributions and have expert knowledge for regional and global syntheses, new research and policy approaches, and solutions to emerging environmental problems.

SCOPE and the Zhongyu Environmental Technologies Corporation inaugurated the Awards program in 2010 to sustain and guide the development of environmental science and technology and foster cooperation in environmental protection and management strategies.

Lifetime Achievements Awards are

John Freney receives his award from (left) Mr Xiaochang Shan, President of Zhongyu Environmental Technology Corporation, and Dr Yonglong Lu, President of SCOPE.



Bucknell honours David Boger

of Building, Construction and Engineering, and in 1991 Managing Director of Sirotech (CSIRO's commercialisation company). Following a CSIRO Board decision to wind up Sirotech in 1992, he worked for CSIRO with Comalco and ASTA on technology capture.

Don left CSIRO in 1996 and was the Executive Director of the Advanced Engineering Centre for Manufacturing at RMIT (1996–98) and was Chair of the Board of the CRC for Polymers (1996–2003). He edited *ATSE Focus* (2005–07) and, with Penny, ran a vineyard in the Pyrenees district of Victoria.

John Simmons adds a footnote that highlights an aspect of Don's life and attitudes: "Don grew up in Killara on Sydney's North Shore and attended Sydney Grammar School. He became conscious of this background and in his last few days in hospital he moralised profoundly as he wrote a fine essay on his iPad titled 'Privilege.'"

Don noted: "That's it in a nutshell really: the privileged should always give something back. It is the only way we can repay our debt."

Tribute edited from contributions by Professor John Simmons AM FTSE, Professor Tom Spurling AM FTSE and Andre Cabelli.

Professor David Boger FRS FAA FTSE has been awarded the Bucknell University College of Engineering and the Bucknell Engineering Alumni Association Distinguished Engineering Alumni Award.

Professor Boger graduated with a Bachelor of Science in Chemical Engineering from Bucknell, at Lewisburg, Pennsylvania. He continued his studies at the University of Illinois, and earned Master of Science and Doctor of Philosophy degrees in Chemical Engineering in 1965.

The citation notes his contribution to chemical engineering as an educator and researcher. He has published in excess of 350 articles in journals and conference proceedings, co-authored five books, produced several films and videotapes illustrating rheological phenomena, and is professionally associated with more than 90 companies worldwide.

THE CITATION STATES:

"You were one of three inaugural Laureate Professors at the University of Melbourne. You have held positions in Chemical Engineering at both Monash University and the University of Melbourne. At the University of Melbourne you were Head of the Department of Chemical

Engineering, Deputy Directory of the Advanced Mineral Products Centre, and Director of the Particulate Fluids Processing Centre – both Australian Research Council Special Research Centres. You served as a past President of the Australian Society of Rheology and were the Australian Delegate on the International committee on Rheology (ICR) from 1978–83, and again from 1990–2004.

Your contributions to fundamental research in fluid mechanics are world-renowned for your discovery of constant viscosity elastic liquids, named Boger fluids, which were synthesised to better understand how non-Newtonian fluids behave. Your detailed experimental investigations used such materials to define fluid elasticity effects in important flows; the linking of basic surface chemistry to the continuum properties and the processing of particulate fluids; the development of novel methods for flow property measurement; and the linking of the basic research to significant industrial outcomes in the petroleum, food and minerals industries. You are well-known for exploiting rheology for waste minimization in the minerals industry."

The citation noted Professor Boger's many awards: the Annual Award of the British Society of Rheology in 1983 for notable contributions to rheology; the 1995 Walter Ahlström Environmental Prize, awarded annually by the Finnish Academies; the Victoria Prize in 2002; the British Society of Rheology Gold Medal in 2004; and the Prime Minister's Prize for Science in 2005.

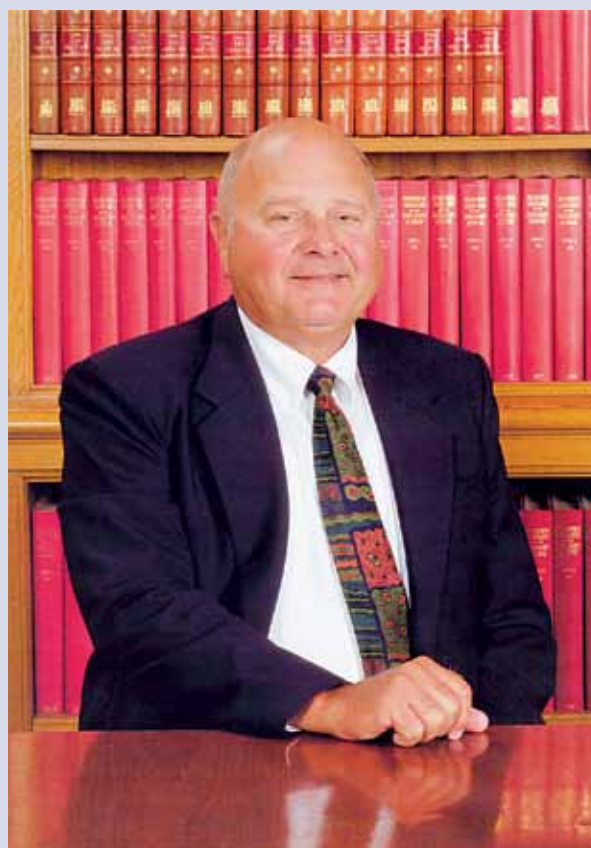
A Fellow of the Royal Society (2007) and an ATSE Fellow since 1989, Professor Boger was awarded an Honorary Doctor of Engineering (*honoris causa*) from The University of Melbourne in 2011 in recognition of his contribution to the field of fluid mechanics.

David Boger

presented every two years to distinguished individuals for their contributions to environmental science, technological innovation or environmental engineering.

Dr Freney, a Fellow since 1986, was honoured for his distinguished career as a research scientist and his authorship of more than 240 authoritative scientific publications. He was particularly honoured for his pioneering work in developing our understanding of the role of agriculture in transforming the global nitrogen cycle, his decades-long active leadership in international science activities, and as an outstanding educator and academic leader.

UNESCO's Scientific Committee on Problems of the Environment (SCOPE) and the Zhongyu Environmental Technologies Corporation aim to sustain and guide the development of environmental science and technology and to foster cooperation in environmental protection and management strategies.



Alan Reid won minerals industry accolades

Dr Alan Reid AM FAA FTSE, the former Director of the CSIRO Institute of Minerals, Energy and Construction (IMEC), who died in Adelaide in January, aged 81, won acknowledgement from the minerals industry for his support of practical application and accountability in research.

Dr Reid had a long and distinguished career with CSIRO (1959–96), starting as a research scientist and serving finally as Director of IMEC (1988–96).

Born in New Zealand and with a passion for mountain climbing, he was awarded an MSc from the University of New Zealand (Canterbury) in 1954 and a PhD (1959) and DSc (1970) from the Australian National University (ANU).



Alan Reid insisted on the highest quality of science but at the same time insisted that the science had application to the minerals and energy industries. One of his greatest successes was to create an environment where great science and direct application came together as a seamless blend.

Apart from a postdoctoral period at Cornell University (1964–66), his entire professional career was spent with CSIRO. In 1972 he was appointed Assistant Chief of the Division of Mineral Chemistry; in 1982, Chief of the Division of Mineral Engineering; in 1984, Director of the Institute of Energy and Earth Resources; and in 1988, Director of the Institute of Minerals, Energy and Construction, which comprised seven CSIRO Divisions.

Dr Reid was an internationally renowned solid state chemist with an overpowering desire to see his own work and that of others applied to the mineral processing industry.

He is remembered as a dedicated and visionary leader. He insisted on the highest quality of science but at the same time insisted that the science had application to the minerals and energy industries. One of his greatest successes was to create an environment where great science and direct application came together as a seamless blend. It was his vision and perseverance that led to the establishment of the CSIRO Minerals and Energy complex at Bentley in Western Australia, and the major expansion and further development of CSIRO's multi-divisional site at North Ryde in NSW.

His early work resulted in patents for titanium processing and he also contributed to the development of commercial solar energy panels though the development of the energy absorber surface, AMCRO. His outstanding achievements lie in the statistics and stereology of mineral particles. This work resulted in the development of what is now commercially available as QEM*SEM, which automatically characterises the mineral assemblages from ore bodies using X-ray analysis based on a scanning electron microscope. The mineral reidite, a high-pressure phase of $ZrSiO_4$, is named after him.

After his retirement in 1997, he remained in close contact with CSIRO as Chairman of the Board of the Australian Petroleum CRC and as Technical Director of Australian Environmental Resources NL from 1997 onwards. He was awarded many prizes, including the CSIRO Rivett Medal in 1970, the Australian Academy of Science's Ian Wark Medal and Lecture in 2008 and the Australian Medal in 1993. He was the Royal Chemical Society Lecturer in Australia in 1988.

Dr Reid was an active Fellow of the Academy of Science, serving on several committees: the Sectional Committee on Applied Sciences (1984–87); the Sectional Committee on Solid and Fluid Earth and Planetary Sciences (member, 1991–92; Chair, 1993–95); and the Ian William Wark Medal Selection Committee (1989). He also served as a member of the Weizmann Institute Fund (1984–88).

He became an accomplished painter and his portrayal of sailing boats with full spinnakers in a shimmering sea at Port Vincent will remain as an outstanding tribute to his life. Amongst other things he loved good wine (red), good art, good food and good conversation. He was

a dedicated collector of Australian (including Aboriginal) contemporary art and was on the Board of the Central School of Art attached to Flinders University.

Dr Ian Gould AM FTSE, Chancellor of the University of South Australia and former head of CRAE and later of CRA R&D, comments:

Alan stood out ... for his understanding of how business worked and what it wanted from CSIRO. He was also a believer that contemporary organisational structure had a place at CSIRO and that future funding from industry was a major component for CSIRO and collaboration with them was essential.

He held the view that researchers should not be supporting personal 'hobbies' and they should be accountable for their outputs and use of funds. Not all his colleagues liked these ideas and Alan bravely took on the task of reforming the way things were done in his Institute and he pursued changes with characteristic determination. He was a pioneer in this area and the minerals industry appreciated his push for science with practical application and accountability. He was also a forthright champion of the industry, when it had plenty of detractors, and he saw that its vital contribution to the Australian economy justified government backing to improve efficiencies and competitiveness and environmental performance.

NORTON JACKSON REMEMBERED

The South Australian Division has honoured the late Norton Jackson AM FTSE, an Academy stalwart from 1981 to 2012, by naming its annual New Fellows Forum in his honour.



Norton Jackson

The 2013 Norton Jackson New Fellows Forum was held in Adelaide in March to welcome new SA Fellows Professor Don Bursill AM FTSE, Mr Jim Hallion FTSE, Dr Paul Heithersay PSM FTSE, Mr David Knox FTSE and The Hon Karlene Maywald FTSE – all elected in 2012.

Shaun Coffey back In Brisbane

Mr Shaun Coffey FTSE, who has headed one of New Zealand's Crown Research Institutes for more than six years, has returned to Brisbane to live. He was Chief Executive of Industrial Research Ltd (IRL) (now Callaghan Innovation) – one of New Zealand's eight Crown-owned companies that carry out scientific research for the benefit of New Zealand – until his retirement from the role in January.

In 2012 he was named as one of the 25 most influential leaders in the New Zealand business community in recognition of his role leading research and development for the New Zealand food, manufacturing and industrial sectors.

An agricultural scientist by training, Mr Coffey held a number of senior positions in Australian agriculture before moving to New Zealand, including Director of R&D at the Queensland Department of Primary Industries, and Foundation Chief of the CSIRO Division of Livestock Industries. He was a session chair at the 2012 Crawford Fund Parliamentary Conference in Canberra.

Mr Coffey leaves IRL–Callaghan after a period of unprecedented success to pursue a number of business interests in both Australia and New Zealand. In addition to his role at IRL, he has served as an Adjunct Professor at the Victoria Management School at Victoria University and the University of Queensland. He is also a Director of numerous other ventures, including General Cable Superconductors Ltd, Quest Reliability NZ Ltd, HTS-110 Ltd, Science New Zealand Ltd and the Measurement Standards Laboratory of New Zealand Ltd.

He holds a Masters of Agricultural Science from The University of Melbourne and a Graduate Diploma in Change Management. An ATSE Fellow since 2004, he is also a Companion of the Royal Society of New Zealand and the Institution of Professional Engineers New Zealand.

IRL chairman Michael Ludbrook praised Mr Coffey for transforming the Crown Research Institute into a national asset "that will be the crown jewel of Callaghan Innovation".

Mr Coffey was awarded the Thomson Medal in the 2010 New Zealand Science Honours for outstanding and



Shaun Coffey

inspirational leadership and commercialisation of science and technology to wealth generation in New Zealand and Australia.

Crown research institutes (CRLs) are Crown-owned companies that carry out scientific research for the benefit of New Zealand. Each of the seven CRLs is aligned with a productive sector of the economy or a grouping of natural resources. On 1 February Industrial Research Ltd (IRL) became Callaghan Innovation, with a team of about 400 researchers, scientists, engineers, technologists, business people investment managers and account managers, working across the country. CRLs date from 1992, with most formed as profit-motivated entities out of the parts of the former Department of Scientific and Industrial Research (DSIR) and elements of various government departments.

JOHN MOORE A LEADER IN COMPUTER ENGINEERING

Emeritus Professor John Moore FAA FTSE, who died in Canberra in January, aged 71, was a former Fellow who won international recognition for his research into control and communication systems and his academic leadership in electrical engineering.

Born in China, Professor Moore completed his undergraduate (1962) and Masters studies (1963) in electrical engineering at the University of Queensland. He then went on to work for Fairchild Semiconductor in California and received his PhD in electrical engineering from the University of Santa Clara in 1966.

He returned to Australia and served as lecturer, Associate Professor and Professor of Electrical and Computer Engineering at the University of Newcastle (1967–82), before joining the Australian National University (ANU) in 1982.

He was a Professional Fellow (1982–90) Professor (1990–92) and Head of the Department of Systems Engineering twice (1992–96 and 2002–06).

Over the course of his academic career, he published more than 200 papers and six books – three in conjunction with Professor Brian Anderson

AO FRS FTSE, who hosted a wake at his Canberra home following Professor Moore's funeral. Professor Anderson proposed his election to the ATSE Fellowship.

Professor Moore was credited, with colleagues, of pioneering Australia's first computer engineering degree program.



John Moore, with colleagues, pioneered Australia's first computer engineering degree program and the polynomial solving routine he developed has been used in IBM software since 1996.

Professor John Hosking, Dean and Director, ANU College of Engineering and Computer Science, noted in a tribute that Professor Moore's work has also been applied commercially in many applications including the polynomial solving routine he developed, which has been used in IBM software since 1996.

Erica Smyth continues on ANSTO Board

Ms Erica Smyth FTSE has been reappointed as a part-time member of the ANSTO Board for five years.

Ms Smyth was appointed to the ANSTO Board in 2008. A scientist and businesswoman with extensive project management and community consultation experience, she has more than 35 years' experience in the mineral and petroleum industries.

She has served as Principal Geologist for BHP Minerals Ltd, Manager for BHP-Utah Minerals International's Beenup Project, Manager Gas Market Development Western Australia for BHP Petroleum and General Manager Corporate Affairs for Woodside Petroleum Ltd.

Ms Smyth has been a professional company director since 2005 and is currently the Chairman of several boards including: Scitech, a hands-on science museum; Toro Energy Ltd, a publically listed uranium development company; and the Diabetes Research Foundation of Western Australia. She is also a director of EMECO Holdings Ltd, the Royal Flying Doctor Service Western Operations and ANSTO, and has served as Chairman and Board member of the Pilbara Development Commission.

She is a former Pro Chancellor and

Senate member of the University of Western Australia and was a member of the university's Geosciences Foundation Advisory Board.

"I am delighted that Ms Smyth has agreed to continue to serve on the ANSTO Board, which has benefited from her experience as a professional company director, scientist and businesswoman," said the former Minister for Tertiary Education, Skills, Science and Research, Chris Bowen.

ANSTO Chairman, Dr Paul Greenfield AO FTSE, also congratulated Ms Smyth on her reappointment.

"Ms Smyth has been a tremendous asset to the Board," Dr Greenfield said. "Her experience has helped ensure that ANSTO Minerals delivers significant financial and environmental benefits to Australian mining and minerals processing customers, enabling safer mining and better products for export."

BRYCE RANKINE WAS OUR LEADING WINE SCIENTIST

Bryce Rankine AM FTSE, who died in Adelaide in February, aged 87, was a doyen of the Australian wine industry and one of the country's most respected wine scientists.

He was known for his role as a researcher at CSIRO and the Australian Wine Research

Institute, wine judge and then the head of Roseworthy Agricultural College, where so many of Australia's great winemakers were educated.

He worked in the Oenological Investigations section of CSIRO from 1950. This evolved into the Australian Wine Research Institute (AWRI) in 1955, where he spent 22 years investigating technical problems in winemaking during a time of great change for the industry. His initial work at the AWRI was on yeasts, fermentation, ethanol production, lead and other metal content in

Australian wines, treating wine with ion-exchange resins and preventing potassium bitartrate deposition in wine.

In a tribute, the AWRI noted that upon leaving Dr Rankine as Principal Research Scientist had published more than 250 papers in trade publications, peer-reviewed journals and for conferences, symposiums and seminars.



Bryce Rankine

"During his 22-year tenure at the AWRI, Bryce was extremely active in visiting wineries and regions to extend his work to help winemakers overcome production issues, and he commenced the AWRI's valuable 'help desk' service, which today services over 1000 calls per year. He also travelled overseas, presenting at conferences and bringing back to Australia information about production practices in other countries, preparing the following papers for the Council of the Australian Wine Research Institute: *Observations on wine making and wine research in France, Germany, Switzerland and California* (1967) and *The South African wine industry – a technical appraisal* (1971)."

In 1978, he became head and later Dean of the School of Oenology and Viticulture at Roseworthy Agricultural College, where he took wine science from a Diploma of Oenology into a BSc degree, before retiring in 1986.

He was internationally recognised as a leading wine academic and much respected by the hundreds of Roseworthy graduates who now populate the Australian wine industry. In his retirement he set up the Australian Society of Wine Educators, and wrote technical books about winemaking for Australian conditions, including *Making Good Wine*, first published in 1989 and still on the syllabus of The University of Adelaide.

His contribution to the wine industry was widely acknowledged. He was a companion of Barons of the Barossa (1976) and received the wine industry's Maurice O'Shea Award in 1998.

Erica Smyth

