

AUSTRALIAN ACADEMY OF TECHNOLOGICAL SCIENCES AND ENGINEERING (ATSE)



FOCUS

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ADVANCED MANUFACTURING

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and move its manufacturing into a
new and exciting era of impact

Clunies Ross Awards



2016 NOMINATIONS NEW FORMAT AND CATEGORIES CALL FOR NOMINATIONS

Nominations for the 2016 Clunies Ross Awards will close on Friday 30 October, 2015

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

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

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

**IF YOU WISH TO NOMINATE A 2016 AWARD CANDIDATE GO TO THE ATSE WEBSITE,
www.atse.org.au/CluniesRossAwards**

CATEGORIES

The three award categories are:

Clunies Ross Entrepreneur of the Year Award

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

Clunies Ross Knowledge Commercialisation Award

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

Clunies Ross Innovation Award

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

CRITERIA

The award criteria are:

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

Clunies Ross Awards

CONTENTS

3

Economic complexity drives national prosperity

By Göran Roos

7

Next-generation manufacturing: a huge opportunity for Australia

By Gordon Wallace

9

We need manufacturing leadership and vision

By Erol Harvey



Front cover photo:
Manufacturing in the 21st century.

iSTOCKPHOTO



The world's fastest radio: connecting New York (Page 16).

- 13 Manufacturing innovation needs partnership
- 16 The world's fastest radio: connecting the New York Stock Exchange
- 18 It's serious: now we have an Innovative Manufacturing CRC
- 22 ATSE backs program to boost women in science
- 22 Clunies Ross Awards closing soon
- 23 Infrastructure planning a 'critical issue'
- 25 Business cases key to nuclear investment
- 26 'Vision for a Science Nation' consultation paper
- 26 Wonder of Science moves to UQ
- 27 ATSE backs WA science councils
- 35 ATSE in *Focus*

FOCUS

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

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

What is the API?

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

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

Value Proposition

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

The key objectives of API are to achieve the following:

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



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By Göran Roos
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Economic complexity drives national prosperity

High economic complexity requires collaboration. It needs designers, marketers, engineers, finance specialists and input from experts in law, HR, environmental science and ITC.

The faster a nation's economic complexity grows, the faster grows its prosperity. Australia's decline in economic complexity is a worrying trend that has emerged over the past 25 years. In absolute terms, Australia's economic complexity is one of the lowest in the OECD. It is time to reverse this decline.

The problem with economic complexity is that it lives up to its name. Yet we ignore its importance at our peril. The alternative is remarkably simple: Australia's standard of living and national prosperity will fall if we do not raise our game.

Conceptually, economic complexity can be difficult to grasp, given its origins in a nation's technical expertise, capital equipment and specialised relationships, processes and knowledge.

In a simplified way we can say that economic complexity is a function of two things:

- our ability to produce and sell goods that no one else is able to produce and sell; and
- the higher the diversity of inputs needed for what we produce and sell, and the higher the share of value-add in this total supply chain that resides in country, the higher the economic complexity.

From this it is clear that the manufacture of physical goods has higher complexity than the production of services and that the manufacture of the tools of production has higher complexity than the manufacture of goods using these tools. It is also clear that the production of systems generates higher complexity than the production of the component parts.

Hence high economic complexity is grounded in a nation's ability to innovate and compete by exploiting its wealth of productive knowledge. This knowledge is held by individuals and organisations but

it is distributed in industry, government, academia and the wider community. It generates productivity and long-term prosperity by capitalising on a nation's wealth of resources, in a continuous process of specialisation and exploitation.

High economic complexity requires collaboration. It needs designers, marketers, engineers and finance specialists. It requires input from experts in law, human resources, environmental science, IT and communications. The greater the number and diversity of experts and the greater their collaboration, the greater is the opportunity for economic complexity.

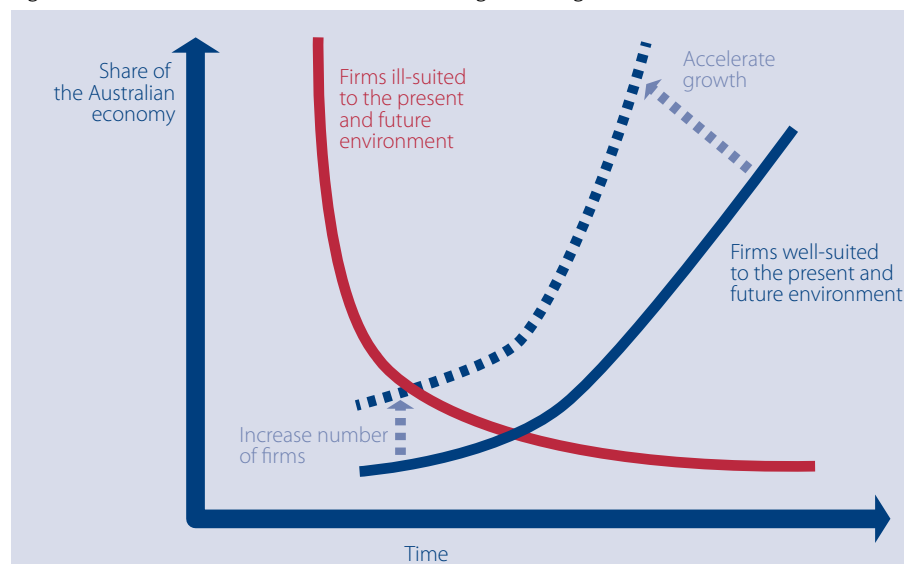
Switzerland is one example of country with high economic complexity. It has maintained a competitive advantage that has little to do with price and everything to do with value – value derived from 21st century manufacturing that draws on other sectors.

Unfortunately, Australia is lagging behind. The past 25 years have seen a decline in the nation's economic complexity, with repercussions for our competitiveness as well as our long-term prosperity given that change in economic complexity is a leading indicator for national prosperity.

Higher economic complexity requires focus, investment and long-term (decades) commitment. It needs to become a long-term national priority, independent of electoral cycles. An example of the principle thinking is outlined in South Australia's Manufacturing Works strategy (Figure 1).

Without a sophisticated 21st century manufacturing sector Australia will not be able to increase its economic complexity and hence not able to increase its national prosperity. The importance of manufacturing is further strengthened for the following reasons.

Figure 1 The South Australian manufacturing challenge.



SOURCE: SOUTH AUSTRALIAN GOVERNMENT, DMITRE, 2012

1 Manufacturing already attracts R&D investment

Most global R&D spending is geared towards manufacturing, be that new 3D-printing technologies, food products for better wellbeing or energy storage for mobile devices.

Yet R&D spending is not evenly spread and countries with higher R&D spending clearly have an advantage.

In the US, manufacturing firms outnumber others by three to one when it comes to the generation of new or significantly improved products or services over a two-year period. This statistic is directly linked to investment. In the US, close to 70 per cent of all business R&D spending takes place in manufacturing firms. Those firms also employ almost 60 per cent of the nation's scientists and engineers.

In the UK there are similar figures. Around three-quarters of the nation's total business R&D expenditure is associated with manufacturing companies, who outnumber other firms producing new and improved products over a two-year period by two to one.

2 Manufacturing drives productivity for wider economic benefit

Historically, manufacturing has seen productivity growth that is three times higher than the average for all industries and sectors. This improvement comes from increased labour productivity and, primarily, through the invention and use of better manufacturing technologies. It is also driven by a better understanding of how general purpose and enabling technologies can be used profitably and effectively.

Germany is investing heavily in this area. It's 'Industry 4.0' policy is transforming manufacturing by embracing the cyber-physical interface, integrating simulation, autonomous robotics, augmented reality, the 'internet of things', vertical and horizontal system integration, big data analytics, cloud-based solutions and cyber security. The outcome is an integrated system that embodies new 'man-machine' interactions. This optimises production flow and minimises resources while achieving greater efficiency. It also leads to changed relationships between

customers, producers and suppliers. Over the next 10 years, one per cent of Germany's annual GDP is expected to be generated by these new technologies, which will also boost employment by six per cent. Importantly, German manufacturing firms will have to (and will most likely) invest 1 to 1.5 per cent of their turnover in the Industry 4.0 technologies, tools and services to achieve that outcome.

3 Manufacturing is a critical contributor to export earnings

Statistics show that manufactured goods are one of the largest contributors to export earnings. Manufacturing businesses are three times more likely to engage in export activities than non-manufacturing businesses. For any country wanting to achieve a trade-driven budget surplus and have the ability to import goods and services without a negative budget impact, a successful export-driven manufacturing industry is essential.

For Australia to grow its economy, sell more goods to the world and replenish

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its workforce, it needs to develop its manufacturing base. Above all, it needs to grow its high-tech export-oriented industries by a factor of five to reach the level of other OECD economies that have higher economic complexity. To dominate their global niche market, Australian firms need to become leaders in their respective fields. They need to continuously invest in new knowledge, new practices, new processes, new production equipment and new offerings. They also need to become fast adopters of new technology, frequently sourced from overseas.

The low level of international engagement found among Australian firms is therefore worrying.

4 'Servitisation' is transforming manufacturing

Manufacturers no longer deliver products alone. They deliver products with services embedded or added on, increasing the value generated. This 'servitisation' is changing the nature of manufacturing while blurring the lines between 'products' and 'services'.

The idea that manufacturing is limited to noisy, dirty and dangerous transformation of raw materials into finished products is outdated. Modern 21st century manufacturing includes a chain of activities including design and research, technological innovation, customer interaction and even recycling of the final product. Physical fabrication is only one small part of a process that today is clean, safe and highly advanced.

Manufacturing is also driving innovation and opportunity in the service sector through its uptake of high-end services that are bought in – in the European Union more than half of all services are related to manufacturing and would disappear if manufacturing disappeared.

5 Manufacturing boosts employment and the economy

There is no doubt that manufacturing makes a key contribution to the economy. In the US, every government dollar

invested in the manufacturing sector delivers a return of US\$1.40. In countries with high economic complexity, the returns on jobs are also greater. High-skilled manufacturing jobs can have a multiplier effect of 3 to 5. There is also evidence that the more complex the system produced, the greater the multiplier effect. In Australia, this is a key reason why economists have argued that the nation's next submarine fleet should be built in-country.

Statistics also show that, on average, manufacturing jobs pay better than other jobs. In California, the average manufacturing job pays about 50 per cent more than jobs in healthcare – the state's fastest-growing industry. In Germany, the average private sector income is 20 per cent lower than the average salary paid by manufacturing firms. In the UK, manufacturing workers earn 10 per cent more than the national average. This pattern of higher salaries can be seen in several countries. It drives further employment due to the purchasing power of manufacturing employees.

There is no doubt that some workers could lose out if Australia invests more heavily in advanced manufacturing due to the new skill sets required and the productivity improvements achieved. The solution is to ensure the presence of firms that, in some combination, serve markets that grow faster or gain market share faster than the world-class productivity improvements achieved.

Australia's opportunity

There are signs of a shift to advanced manufacturing already in one Australian state due to the demise of the automotive industry.

In South Australia, the electronics industry has emerged as a key driver of economic growth, with annual productivity of \$343,600 per employee and an annual growth rate of 13 per cent in terms of turnover and five per cent in employment.

Currently, the industry turns over

US\$5 billion annually. It has become an established and growing design and manufacturing industry with 11,700 well-trained and well-paid staff employed in 300 companies. Most are privately held, representing 15 to 16 per cent of all 74,400 manufacturing jobs in SA.

Those companies design and build non-consumer products for industry, commercial and government use. Production often involves small volumes of high-tech, customisable products based on controlled IP for global markets. Small volumes and high complexity provide long-term industry sustainability.

Given that electronics is a key enabling technology, the industry's know-how offers a competitive advantage to other sectors. The potential for Australian electronics firms to export their expertise to countries seeking new solutions, new designs and new opportunities cannot be underestimated.

Yet the electronics industry is just one example of advanced manufacturing in action. What is needed, nationally, is a long-term plan to restore Australia's status as a global hub for key enabling-technology-based innovation in the 21st century manufacturing sector.

The foundation is already in place, given the manufacturing base that Australia already has. The challenge now, is to set our sights higher.

PROFESSOR GÖRAN ROOS FTSE is a member of the Economic Development Board of South Australia and the Council for Flinders University. He is a Stretton Fellow appointed by the City of Playford at University of Adelaide; Adjunct Professor at the Entrepreneurship, Commercialisation and Innovation Centre, University of Adelaide; Adjunct Professor, University of Technology Sydney Business School; and Adjunct Associate Professor, College of Business, Nanyang Business School, Nanyang Technological University, Singapore. He has worked as a consultant in more than 50 countries, has served in management positions in several European and US-based corporations and is one of the founders of modern intellectual capital science.

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

Enhancing Australia's prosperity through technological innovation

The Australian Academy of Technological Sciences and Engineering (ATSE)

ATSE is made up of some of Australia's leading thinkers in technology and engineering. One of Australia's four Learned Academies, it's an eclectic group, drawn from academia, government, industry and research, with a single objective in mind – to apply technology in smart, strategic ways for our social, environmental and economic benefit.

To achieve that goal, ATSE has formed a variety of expert, independent forums for discussion and action – platforms to move debate and public policy on issues concerning Australia's future. These focus on energy, water, health, education, built environment and innovation – and the international collaboration necessary to ensure that Australia is abreast of world trends.

It's an open, transparent approach – one that government, industry and community leaders can trust for technology-led solutions to national and global challenges.

Each year, the Australian Government recognises the importance of the work we do by awarding the Academy an establishment grant to help with:

- Fostering research and scholarship in Australia's technological sciences and engineering;
- Providing and conducting administrative support, workshops, forums and similar events to enable the Academy and its Fellows to contribute on important national issues;
- Managing the development and execution of our programs; and
- Supporting relationships with international communities.

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By Gordon Wallace

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The Port Kembla copper stack comes down in 2014: the end of an era.

PHOTO: KIRK GILMOUR, ILLAWARRA MERCURY

Next-generation manufacturing: a huge opportunity for Australia

Opportunities for localised niche manufacturing with low capital investment are emerging and require technically competent, communicative and creative individuals.

The demise of traditional manufacturing in Australia creates an enormous opportunity for us to reinvent ourselves.

The more traditional, capital-intensive, faster, cheaper, mass-manufacture approach can no longer be sustained. Maybe now we can unshackle our thinking and throw away the blinkers that had us careering down an increasingly narrow manufacturing pathway. Economic factors have forced us to realise that's not a race we should be in – and maybe just in the nick of time.

Now is the time to tap into a stockpile of advances in materials science, amassed over three decades. We can pursue opportunities that have often been stymied with the 'it doesn't fit here' attitude prevalent in the traditional manufacturing sector.

Now is the time to embrace the challenge and to create new industries based on innovative manufacturing – industries that capture the extraordinary properties of new materials in useful structures and devices.

Australia has a proud history of bringing together materials science and new manufacturing opportunities. Our materials science and engineering heritage is founded in metallurgy and the industries that arose from this.

Our local area of Wollongong, NSW, is a prime example. The establishment of the copper refinery more than 100 years ago was based on state-of-the-art electrochemical technology. The Port Kembla steelworks has led the world in a number of areas since 1921. The introduction of Colorbond in 1966 revolutionised the building industry. Zinalume steel greatly extended product life by providing unprecedented protection from corrosion.

The development of high-strength steels for the automotive industry and thin strip casting process were amongst the innovations that kept the steelworks at the forefront of manufacturing. They could do things that others could not.

A more topical example, graphene, is

a recently discovered material generating excitement amongst miners, researchers and product developers alike. We have in our research stores, a scientific understanding of this wondrous material. We have at our disposal chemistries that can impart amazing properties into useful structures.

The work of our team within the ARC Centre of Excellence in Electromaterials Science (ACES) and that of the Monash Centre for Atomically Thin Materials, as well as others around the country, mean we are well placed in this field.

Our first foray into graphene was very much with an eye towards how we could make stuff containing this amazing material. Our first publication described simple chemistries that resulted in the ability to spray, print and otherwise coat graphene onto other structures.

Subsequent work at ACES has developed chemistries that enable us to create stand-alone graphene structures



Training students in next-generation manufacturing – Jeremy Dinoro and Malachy Maher are two of the first intake in the UOW/QUT Masters of Philosophy in Biofabrication degree. PHOTO: UOW

using fabrication methods such as fibre-spinning or 3D-printing. Through the development of appropriate chemistries, we have been able to realise composites with biomaterials or other polymer hosts.

Of course, graphene is just one example. Numerous groups across Australia are carrying out ground-breaking research on a range of new materials.

A knowledge base

Next-generation manufacturing requires new generation materials. We are fortunate that Australia has amassed a mountain of knowledge in this area over the past three decades. Australian researchers across universities and CSIRO are at the forefront of numerous areas.

At the ARC Centre of Excellence in Convergent Bio-Nano Science and Technology researchers have developed new nanomaterials for biological applications including drug delivery. The centre also uses 3D cell printing to form 3D constructs as assays to more closely mimic in-vivo studies to reduce the need for animal experiments.

The team at the ARC Centre of Excellence for Nanoscale BioPhotonics is developing biologically compatible light guides, as well as materials for new light sources and detection systems.

Researchers at the ARC Centre of Excellence for Ultrahigh Bandwidth Devices for Optical Devices are developing

state-of-the-art photonic chips based on hybrid geometries, created on silicon with other novel materials.

Our team at ACES is now developing new nanostructured electromaterials for energy storage/conversion and medical bionics. Fabrication tools (including 3D printing) that enable these nanocomponents to be captured in microstructures within macroscopic devices are being developed in tandem.

In all ARC Centres of Excellence, there are cauldrons of activity boiling over with ideas, some of which can undoubtedly be turned into new manufacturing industries.

Training framework

We need to be nimble in our approach to education and (re)training to provide a new workforce made up of people equipped with the skills necessary for next-generation manufacturing.

The University of Wollongong and Queensland University of Technology have recently joined forces with universities in the Netherlands and Germany to introduce a new Masters of Philosophy in Biofabrication course – printing parts for bodies.

Next year the University of Wollongong and Deakin University will launch Australia's first joint postgraduate degree in electromaterials science, with emphasis on the use of new fabrication tools to build devices containing next-generation materials.

The development of skills that enable the individual to work as part of an integrated team, taking breakthroughs in materials science into a fabricated device will provide graduates ready to create and participate in next-generation manufacturing.

New business models

A revolutionary approach to manufacturing requires the development of new business models. Not all opportunities need to be based on capital-intensive operations run by robots.

Opportunities for localised niche manufacturing with low capital investment are emerging. Technically competent, communicative and creative individuals are required to facilitate such operations.

The old adage 'Equipment is an asset, people are a liability' is now a thing of the past.

I see a groundswell of individuals with the capacity to change how things are done in the manufacturing space. Already, new Australian companies that use 3D printing for manufacturing, or sell 3D printers and 3D printing supplies, are emerging.

Australia is well placed to create next-generation manufacturing industries. We have a strong, internationally recognised research base in materials science. We have adopted, adapted and developed new approaches to fabrication and manufacturing. We have world-class training.

We are well equipped with the basic ingredients needed for success in next-generation manufacturing. Our challenge is to continue to improve processes that facilitate blending and integration of these capabilities to ensure success.

PROFESSOR GORDON WALLACE FAA FTSE is an Australian Laureate Fellow and Director of the ARC Centre of Excellence for Electromaterials Science. With his team he pioneered the use of nanotechnology to create new electromaterials for use in energy storage and medical bionic devices. Professor Wallace was awarded an Australian Research Council QEII Fellowship in 1991, an ARC Senior Research Fellowship in 1995, an ARC Professorial Fellowship in 2002 and a Federation Fellowship in 2006. He was awarded a DSc from Deakin University in 2000. He has more than 800 refereed publications, 26,000 citations and has supervised 90 PhD students to completion.



By Erol Harvey
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We need manufacturing leadership and vision

A reliance on market forces to let the strongest float to the top seems doomed to condemn us to reliance on good luck more than strategy.

There are an emerging number of successful high-technology manufacturers in Australia. Typically these enterprises are specialists, globally competitive and with a well-focused offering that differentiates them in the international market.

Australia is among the highest-cost countries in the world for manufacturing, ranking with countries such as Switzerland, Germany and Belgium. These countries have thriving manufacturing businesses and it is with these countries that Australia should compare itself.

In today's post-tariff, globally connected market we must test our business models against the white heat of international competition and not rely on domination of our relatively small domestic market, important as this may be in some instances.

Professor Göran Roos FTSE, a world leader in business model innovation in manufacturing and a recognised expert in innovation management and strategy, has previously noted nine key aspects for successful manufacturing enterprises:

- experienced entrepreneurial leadership with ambitious goals;
- innovation integrated into the company;
- partnerships that reduce risk and drive innovation;
- products and services of high performance, quality and value;
- loyal and knowledgeable employees;
- strategic alignment with customers;
- decentralised business structure;
- global; and
- focus and depth.

None of these focuses on strong patent position. While an important element in some businesses, a focus only on patent portfolio does not in itself guarantee manufacturing success. Indeed many manufacturers provide capability as a service that relies on building and retaining

in-house know-how rather than published patents.

One such example is Melbourne's MiniFAB. Formed in 2002 and now employing more than 120 people, MiniFAB's focus area is polymer microengineering with an emphasis on microfluidics and medical diagnostics.

MiniFAB's founders recognised that few people had the skills and capability for translating research outcomes into manufacturable products. Through attendance at commercialisation conferences around the world it was evident that this was a global problem and that a business solution addressing this need would have a global customer base, even though the domestic market for this service was too small to support a viable business.

Like all technology start-ups MiniFAB applied for the support packages then offered by state and Commonwealth agencies – an approach which was largely unsuccessful since program reviewers at the time looked poorly at service business

models and assumed that local success was required before growing export opportunities.

How has this changed today? Well, there is little need to educate reviewers since the drastic reduction in any business support programs seems to be the most notable characteristic of today, in contrast to more aggressive publicly funded support programs available elsewhere.

The huge European Horizon 2020 Program (the successor to the Framework programs) is well known, while in the US, company innovation is supported by a wide range of Small Business Innovation Research (SBIR) grants, state-based initiatives, and the increasing 'American Made' campaign encouraging repatriation of manufacturing from Asia. Through agencies such as Defense, Energy and Homeland Security there are many deep programs that provide pre-market stimulation of technology-based businesses.

MiniFAB's business model was based on a recognition: we recognised



Inside the MiniFAB manufacturing facility.



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that its customers, the majority of whom are in North America and Europe, required expert assistance in product development and valued its clear pathway to manufacture. Contracting MiniFAB's services allowed these customers to focus on building the relationships and partnerships that created the channels to market, and raising the capital required to create new products and services.

Creating and growing the patent portfolio that supported this was more important to them than it is to MiniFAB, hence it supports them in this activity. MiniFAB becomes the natural choice for manufacture since it was responsible for the product development and highly motivated to see it succeed.

Contracts for second-generation products are more likely to be awarded because of the existing strong collaborative relationship. As a result, MiniFAB has successfully completed more than 900 projects and currently manufactures and exports millions of microfluidic medical devices per year.

Another example of a successful Australian manufacturing company is electronics firm SRX Global. Based in Dandenong, on Melbourne's outskirts, the company recognised a global need for technology-leading production of small runs of electronic units and the build of complete systems, especially where they needed to meet regulatory standards for industries such as health.

The firm's competitive advantage is an operational efficiency that allows it to rapidly and cost-effectively reconfigure its production process for small runs of high-value products. SRX Global has a second manufacturing facility in Malaysia that allows it to cost-effectively meet the requirements of larger production runs, and this too is a thriving facility.

Many of SRX's customers are Australian companies who export their products to international markets in health, automotive and IT security industries.

Australia has a wide range of specialist technology-based product-development companies. MiniFAB is an example of a development company with a strong transition-to-manufacturing focus in the area of polymer microfluidics and medical devices, while other companies focus on

THE TRUTH ABOUT US MANUFACTURE

At a talk given to the AIRG 50th Anniversary conference earlier this year, Edward Bernstein, President of the Industrial Research Institute, reviewed the trends in industrial investment in research and innovation in the USA. Used as a barometer for industrial sentiment, the data showed cautious optimism and a trending increase in R&D investment.

Surprisingly, he went on to emphasise that this was all without the influence of government programs. He described a technology and manufacturing innovation system that I could not recognise and is at extreme odds with our primary client base – innovative ventures and established companies in the US.

We compete with companies that are heavily supported by US Government programs such as SBIR, DARPA, state-based packages and other Federal programs. The

vast military procurement process heavily intercedes in business innovation, supporting local investment and development and broad areas such as health, ICT, transport and energy, as well as security.

Often these programs mandate that manufacture must take place in the US. Indeed, many of our clients are supported by these programs and, understanding what it takes to win these grants, we have helped some of our early-stage clients in the US apply for and win such grants so that they could contract our services.

We should not be afraid to compete in this environment, and we do so along with many other Australian companies. Nevertheless I am bemused when our US friends claim that they do not rely on government programs and then dismayed when local policy-makers unquestioningly believe this.

instrument development, industrial design and software development.

Design companies such as Axxin, Planet Innovation and Invitech are often better-known internationally than locally, reflecting their success at tapping into global markets. Sometimes called micro-multinationals, such companies are often born global.

Mesoblast is a case in point. In 2004 when Mesoblast started it had only a handful of employees more or less evenly distributed throughout Australia, Singapore and the UK. Today the ASX-listed, \$1.3-billion stem-cell company still has a decentralised business structure, employing about 120 people primarily in the US, Singapore and Australia.

Of course, it is important to have some unique element in the product or service offering. Patents could be part of this, but ideally the highest value is added by experience and track record – but these characteristics take years to build and everybody has to start somewhere.

It is increasingly difficult to generate and maintain this unique element solely using internal resources, so partnerships, collaborations and other informal external relationships are critical. This requires ongoing investment in collaboration, equipment, processes, staff and innovation

and is critical to creating and maintaining a competitive edge.

Privately owned businesses are more likely to have a lasting impact on Australia's employment scene than publicly listed companies. Since public companies must optimise value for their shareholders, there will inevitably come a time when the Board must consider whether Australia is the best place to maintain manufacturing operations.

The recent decision of biotech firm Biota to shift operations to the US is a case in point. In contrast, privately owned enterprises will make investment decisions on more financially 'irrational' grounds, such as social or community connections or a desire to create something for subsequent family generations.

These are the business decisions that have built the remarkably strong, privately owned *Mittelstand* companies of southern Germany that are globally recognised for their technical excellence, focus and longevity (many more than 100 years old).

Banks have an important role in supporting the growth of these businesses, rather than seeing them as financial commodities. Australia should be creating publicly funded co-investment programs that more actively strengthen and support privately held businesses, rather than

forcing them to go public too early in order to raise growth capital.

How can we predict which businesses will attain this success? Should we pick a sector? Would it be health technologies, food and fibre, or software? Historically our celebrated successes such as CSL, Cochlear or Resmed have not emerged from a wide base of supporting businesses. Rather they have emerged as highly specialised niche players. This makes it difficult to predict where the next success might come from.

The key to the success of any of these is inevitably the result of individuals with ambitious goals providing experienced entrepreneurial leadership. We should be creating environments that nurture these entrepreneurs rather than awaiting economic transformation to evolve on a

sector-wide basis. In other words, we need to pick winners and support them.

In Australia we have the challenge of transforming, in a very short timeframe, our manufacturing industry from vertically integrated businesses operating in protected or semi-protected markets to specialist, high-value players in the global markets.

In spite of decades of warning about this impending change, we have had to wait for crisis to apply a sense of urgency. We must do in a few years what it took the Swiss watch industry a generation to accomplish.

At times like this we require leadership and vision for our manufacturing sector, and the courage to support individual entrepreneurs to become focused, high-value, global players. A reliance on market forces to let the strongest float to the top,

the current theme of much policy debate, seems doomed to condemn us to reliance on good luck more than strategy.

DR EROL HARVEY FTSE is CEO of MiniFAB (Aust) Pty Ltd, a product-development company and OEM volume manufacturer of polymer-based microfluidic, lab-on-a-chip diagnostic devices for clients around the world. Originally trained in laser and plasma physics, he has been involved in commercial and academic development of micro-, nano- and bio-production techniques for more than 20 years. A former Professor of Microtechnology at Swinburne University, he served on the Australian Government's Future Manufacturing Industry Innovation Council, and is a member of MANCEF, the global association focused on the commercialisation of small technologies, and the Victorian Manufacturing Hall of Fame.

Australian 'printed' ribs in cancer surgery first

A Spanish cancer patient has received a 3D-printed titanium sternum and rib cage that were designed and manufactured in Australia.

Suffering from a chest wall sarcoma (a type of cancerous tumour



How the 3D-printed sternum and rib cage fit inside the patient's body.



The sternum (the central piece) and the ribs were designed using precise scans to perfectly fit in the patient's chest.

that grows, in this instance, around the rib cage), the 54-year-old man needed his sternum and a portion of his rib cage replaced.

This part of the chest is notoriously tricky to recreate with prosthetics, due to the complex geometry and design required for each patient. So the patient's surgical team at the Salamanca University Hospital determined that a fully customisable 3D-printed sternum and rib cage was the best option to replicate the intricate structures of the sternum and ribs.

They turned to Melbourne-based medical device company Anatomics, which designed and manufactured the implant utilising CSIRO's 3D-printing facility, Lab 22, at Clayton, in Melbourne.

Using high-resolution CT data, the Anatomics team was able to create a 3D reconstruction of the chest wall and tumour, allowing surgeons to plan and accurately define resection margins.

"From this, we were able to design an implant with a rigid sternal core and semi-flexible titanium rods to act as prosthetic ribs attached to the sternum," says Anatomics CEO Mr Andrew Batty.

Lab 22 used its \$1.3 million Arcam printer to build up the implant layer-by-layer with its electron beam,

"3D printing has significant advantages over traditional manufacturing methods, particularly for biomedical applications," says Lab22's Ms Alex Kingsbury. "As well as being customisable, it also allows for rapid prototyping, which can make a big difference if a patient is waiting for surgery."

Once the prosthesis was complete it was couriered to Spain and implanted into the patient.

"The operation was very successful," said surgeon Dr José Aranda. "Thanks to 3D printing technology and a unique resection template, we were able to create a body part that was fully customised and fitted like a glove."

The patient was discharged 12 days after the surgery.

PHOTO: ANATOMICS



By Michael Edwards
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Manufacturing innovation needs partnership

Over the past few years, across the manufacturing sector, Australia has demonstrated an ability to create globally competitive, high-value, high-tech products.

The landscape has changed dramatically for some sectors of Australian manufacturing over the past few years and the challenges facing a broad mix of industries are many and varied, and well documented.

Many of the local challenges are driven by global issues that are not always easy to control. However, our investment in innovation to support the growth and productivity of our Australian businesses is a primary lever that is largely within our strategic control.

Boeing Aerostructures Australia (BAA), in Fishermans Bend, Victoria, is focused on high-tech, high-value composite manufacturing for advanced aerospace components. More than 1300 employees are delivering on Australia's largest commercial aerospace export contract to build all the moveable trailing-edge components (flaps and ailerons) for the newest and most technically advanced commercial aircraft in the world, the 787 Dreamliner.

The 787 will literally not fly without Australian innovation and productivity. Importantly, the aerospace composites technology used to produce these flight control surfaces for the 787 Dreamliner was developed, certified and production-hardened right here in Fishermans Bend in concert with numerous partners across the innovation system and local supply chain.

BAA also manufacture numerous other export components for Boeing's commercial aircraft family, including ailerons and tabs for the 737, rudder and elevators for the 777, and leading-edge flaps for the 747. These are all sole-source, high-value manufacturing export contracts for Australia, feeding into a record and growing commercial aircraft order book for the company.

In light of this the pressure is rightly on our global manufacturing operations, including BAA here in Australia, to profitably



Victoria's advanced manufacturing precinct with BAA Fishermans Bend in the foreground.

burn down that backlog and convert it into true economic value for the company. We are absolutely focused on ensuring BAA remains productive and competitive over the long term in order for Australia to prosper from the export growth potential of this market over the coming decades.

Boeing Research & Technology Australia (BR&T-Australia) is one of six international research centres for the company and the largest outside the US. BR&T-Australia has built critical mass in areas of expertise that support the growth and productivity of our local Boeing business units, while strategically collaborating with many of the best aerospace research institutions across the country.

We have invested heavily in co-locating world-class R&D facilities with the 787 factory at Fishermans Bend to ensure that transition and scale-up of technological advances can move seamlessly and efficiently into the production environment.

The majority of our research engineers working on tomorrow's challenges for the production environment come with first-hand production design and engineering experience, so they have embedded and intimate knowledge of how to scale and

transfer technologies from the research world into the factory. The research facility is right next door to the factory floor and they work in partnership with the production staff every day. As we work hard to come down the cost curve on new manufacturing programs such as the 787 Dreamliner, they know where the biggest 'bang for buck' is in production, and how to deliver it.

BR&T-Australia researchers live by a mantra of "cost, weight and simplicity", a relentless drive to:

- reduce the cost of manufacturing operations through productivity gains;
- always look for step-change weight savings on aerospace components to enhance the efficiency of our customer's operations; and
- keep it simple – which means simple in terms of design and simple in terms of manufacturability: a complex integrated design that delivers lower weight is of no benefit if it is more costly and difficult to produce.

These new products and technologies are also being underpinned and accelerated by a new industrial revolution. And this revolution offers very real opportunities for

To know that I can impact on people's lives is such a motivating and inspiring feeling

Hosam, UQ PhD student

Under the mentorship of renowned infectious diseases expert Professor David Paterson, Hosam is creating a diagnostic tool to rapidly identify antibiotic-resistant superbugs, to help save lives. The tool has the potential to allow patients to be treated quickly and minimise opportunities for the deadly superbugs to spread. By learning to see the world differently, Hosam is creating change. See Hosam's story at uq.edu.au/createchange



THE UNIVERSITY
OF QUEENSLAND
AUSTRALIA



Create change

the Australian aerospace sector. There are a whole range of breakthrough technologies that are changing the way we think about aerospace design and manufacturing over the long term.

Technologies such as digital manufacturing provide opportunities to be leaner and smarter, and to drive more of the design and development work into the virtual world, resulting in substantial cost and risk reductions. It allows for alternate business models to be explored, so we end up with organisational innovation accompanying and complementing technology and process innovations.

We are seeing the emergence of new tools, new materials and new processes. Advances in software and communications technology are continuing at a breathtaking pace. Big data and the industrial internet, low-cost computing, automation and robotics, nanotechnology, and unprecedented levels of precision are particularly exciting for our sector.

Historically, aerospace has led the charge on ground-breaking technology developments, and this is still the case. But in this domain we are now sharing the limelight with other high-tech industries such as biomedical, automotive and even sport. Flexible and agile companies, equipped with the latest skills, technology and processes, are now able to design, make and deliver high-value products in extraordinarily fast turn-around times.

As such, trends in manufacturing are moving beyond simple quality and productivity improvements. These changes are boosting efficiency, employee safety and improving performance, driving relentlessly competitive global industries to engage in a determined search for even better tools, talent and technologies.

Manufacturing today is a highly skilled, high-tech occupation, sitting at the intersection of two worlds: the physical and the virtual. It is increasingly as much about engineering and design as it is about knowledge and software. Manufacturing has moved to a smart, design-led industry that sits at the very heart of innovation.

Australian advanced manufacturing is set to prosper in this era of Asian growth – in aerospace, food processing, medical devices, mining technology, robotics and unmanned systems, pharmaceuticals,



Robotics researchers at BAA.

biotechnology and therapeutics, and clean-energy technologies.

With regard to clean technology in particular, competitive manufacturers around the world are heavily focused on reducing their energy footprint as a component of their manufacturing costs, as is certainly the case at BAA Fishermans Bend. This trend toward long-term efficiency in energy consumption and clean manufacturing is vitally important to ensure future competitiveness in a carbon-constrained world.

Australia's strong national innovation system lends itself to success in all of these areas, with world-class universities, a collaborative environment and excellent provisions for the protection of intellectual property, and strong publicly funded research organisations such as CSIRO.

Over the past few years, across the manufacturing sector, Australia has demonstrated an ability to create globally competitive, high-value, high-tech products. But to do this consistently in the future will require sustained investments in innovation that drive continuous growth and productivity improvements for businesses large and small.

These investments will drive individual company prosperity and enhance our national economic complexity, which in turn feeds ongoing renewal and innovation.

At Boeing, we know we don't have a monopoly on good ideas and we recognise the strategic imperative of this sustained investment in innovation. We've been most successful in Australia and in our broader global enterprise when we join with industry partners, with scientists and researchers, and with our employees and customers to solve problems and take advantage of emerging opportunities.

Increasingly, and proudly, we are able to do much of this with unique Australian know-how, which is precisely why Boeing Australia is the largest growing footprint for the company outside the USA.

MR MICHAEL EDWARDS FTSE is General Manager, Boeing Research & Technology Australia. He is also an industry member of the Strengthened Export Controls Steering Group of the Australian Department of Defence; Co-chairman of the DSTO/Boeing Strategic R&D Alliance Management Committee; Chairman of the RMIT University School of Aerospace, Mechanical and Manufacturing Engineering Industry Advisory Board; member of the CSIRO/Boeing Strategic Alliance Steering Committee; member of the Auto CRC Education & Training Advisory Committee; and industry representative on the Swinburne Business School Industry Advisory Board. Mr Edwards has broad industry experience, including 11 years in senior roles with CSIRO.

By Rowan Gilmore
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The world's fastest radio: connecting the New York Stock Exchange

Purchasing officials feel safer buying from a large offshore corporation than an innovative Australian small business. They need to innovate and see the bigger picture.

Strong industry–research organisation collaboration between Brisbane-based microwave company EM Solutions and the Digital Productivity Flagship of CSIRO have produced a radio solution underpinning the future operations of the New York financial markets.

Developed from intellectual property contributed by both organisations, a network of Australian-designed and manufactured radios will shortly be used to connect the New York and Nasdaq stock exchanges, providing unprecedented speed and latency to financial traders.

The multi-million-dollar collaboration, initiated by Fellows Dr Rowan Gilmore FTSE and Dr John Ness FTSE, from EM Solutions, Dr Ian Opperman FTSE then from CSIRO, and Dr Jay Guo FTSE, now at UTS, resulted in a commercialised product that transmits and receives data at fibre-like rates but with 20 per cent faster end–end propagation time than fibre.

The new E10G radios, operating in ultra-high-capacity radio E-band at 80GHz, support data throughputs three times faster than the closest radio competitor – and over link distances twice the length, at a fraction of the latency (defined as the time interval between initiating a query, transmission, or process, and receiving or detecting the results).

Because radio waves propagate through air faster than through fibre, wireless links achieve lower end-to-end latency. This makes radio preferable to fibre for applications where microseconds matter, such as with high-frequency trading. However, microwave wireless systems lack the capacity of fibre to carry large volumes of traffic.

Because mm-wave (or extremely high frequency) systems can use much larger bandwidths to support data rates of several gigabits per second, E-band systems are

One of Australia's eight new national Science and Research Priorities is 'high value and innovative manufacturing'. This case study illustrates opportunities for Australian advanced manufacturing that meet this priority.



A pair of radios being readied in production.

growing in popularity to carry data traffic as volumes explode. Unfortunately, the transmission distance of E-band links has been limited, preventing their widespread adoption for wireless backhaul.

The classic way of increasing hop length (from router to router) between radios is to increase the transmitter power, but at mm-wave frequencies the power is limited by the available transistors and power amplifiers. An alternative is to increase the antenna gain – doubling the diameter of an antenna increases the link budget by four times per end, or 16 times for each hop. The most common E-band antennas are 300mm in diameter; therefore using a 1200mm antenna achieves a significant improvement in link budget and consequently range.

Unfortunately, such a large antenna will have a beamwidth of just 0.25 degrees at E-band: a pencil-thin beam

narrower than a laser pointer. This makes it impossible to manually align two ends of such a link several kilometres apart, or to maintain such alignment when the antennas and their towers are subjected to wind or temperature changes that arise during normal operation. Even smaller antennas that have a broader beamwidth can otherwise take hours to manually point towards each other using optical telescopes, with no resilience to any small motion at either end.

To overcome this limitation, E10G antennas are mounted on steerable gimbals driven by motors. By measuring the strength and phase of a separate broader beam-tracking signal transmitted from each end, a sophisticated pointing system can drive the motors to re-centre the antenna along boresight and ensure both ends 'see' each other prior to transmission.



The radio mounted on a NYSE server building with Manhattan in the background.

Such a system proves remarkably effective at acquiring the remote end in a matter of seconds and maintaining lock even when the towers at both ends are moving.

In this way, large antennas can be steered to transmit data at the speed of light along relatively long paths, and provide sufficient gain to traverse even a path made lossy (with energy dissipation) by the effects of rain and fog.

The latency that the radio itself adds to the propagation time is so small as to be almost negligible. This has ensured the E10G a captive market in the financial sector and, as the product matures and its cost is reduced, ongoing markets in public telecommunications.

There have been several contributors to this successful commercialisation and manufacture of an Australian advanced technology product.

1 Early identification of a lead customer prepared to advise on specifications and invest in development.

In fact the customer first approached CSIRO based on their research publications, but CSIRO then astutely sought an experienced commercialisation partner in EM Solutions and its subsidiary EMClarity to develop the product.

2 Collaboration that brought a unique combination of technology and skills from both organisations, and shared the risk.

EM Solutions provided the innovative automatic pointing technology and RF integration skills needed to steer big, high-frequency antennas, while CSIRO contributed its broadband digital radio modem technology that enabled the extremely low latencies to be achieved.

3 Judicious use of overseas supply chains where appropriate, to take advantage of lower cost materials and labour and to undertake initial product assembly.

4 The company's exposure to global markets, where the incessant pressures of both demand and competition have sharpened skills.

A lower Australian dollar has also undoubtedly improved the competitiveness of pricing in global markets. The biggest barrier to advanced Australian manufacturing may well be penetrating the home market first.

Exporting almost all of its products to blue-chip customers overseas through competitive tendering processes, EM Solutions' biggest challenge has been entering Australian supply chains dominated by foreign multinationals.

Too many potential Australian buyers

prefer to procure advanced manufactured product from offshore suppliers. Whether they work in telecommunication or utility companies or defence, purchasing officials feel safer buying from a large offshore corporation than an innovative Australian small business.

The attitude that 'nobody ever got fired by buying IBM' is pervasive in our culture.

But as the Queensland Health payroll fiasco has proven, at taxpayers' expense, bigger is not necessarily better, nor risk-free. Our own procurement people need to innovate themselves and see the bigger picture.

DR ROWAN GILMORE FTSE joined EM Solutions as a Director in 2007 and became Managing Director and CEO in October 2011. His role is to lead EM Solutions to achieve its vision to become recognised internationally as the leading designers and manufacturers of the most innovative and highest-quality microwave product technology. He was previously Vice President of Engineering at Compact Software, Vice President of Network Services Europe for SITA-Equant, the global airline IT company, and CEO of the Australian Institute for Commercialisation. Dr Gilmore has a DSc in electrical engineering from Washington University, St Louis, and is an adjunct professor at the University of Queensland.

LETTERS TO THE EDITOR

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

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

Please address to editor@atse.org.au

By Calum Drummond and Swee Mak

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It's serious: now we have an Innovative Manufacturing CRC

Our future will be governed by our ability to sustainably convert knowledge to innovative processes, products, services and business models.

A very large chunk of Australia's innovative capacity is associated with the manufacturing sector, either directly through firms that manufacture goods or indirectly through sector service providers.

More than 900,000 Australians are employed in the manufacturing sector, which contributes almost \$100 billion annually to Australia's GDP and accounts for more than 30 per cent of Australia's merchandise exports. The manufacturing sector also contributes almost a quarter of Australia's business expenditure in R&D.

Just as a healthy natural ecosystem is one possessing biodiversity, a healthy economy is one with industrial sector diversity. An Australian economy with a weak manufacturing sector would be fragile and at heightened risk. An Australian economy that lacks a highly diversified competitive manufacturing sector will be threatened by Darwinian international trends.

One can argue that Australia's future is locked in step with the future of Australian technological science and innovation. This is particularly so when the world is experiencing a level of technological disruption that poses immense challenges as well as opportunities for Australian industry.

Consequently, in order to ensure a prosperous future we need to nurture and advance our innovative capacity – our manufacturing capability. Our future will be governed by our ability to sustainably convert knowledge to innovative processes, products, services and business models.

Recognising the importance of innovative manufacturing to obtaining a desirable Australian economic future, two years ago many elements of the national innovation system – industry representation groups (such as AI Group and AMTIL), individual firms (large



Aerospace bracket manufactured from titanium on a selective laser melting machine at RMIT's Advanced Manufacturing Precinct as part of a project involving DMTC and Lockheed Martin.

and small), universities and CSIRO – came together to create a proposal for an Innovative Manufacturing (IM) CRC.

This IMCRC was awarded Commonwealth funding earlier this year and has more than 20 foundation participant organisations. It is expected to exhibit further marked growth in the participant base, especially SMEs, in its first year of operation. The current interim CEO is Dr Mark Hodge, a Monash University engineering graduate who is also inaugural CEO of the Defence Materials Technology Centre (DMTC).

Four programs

IMCRC has four programs of interconnected activity. Through industry-driven research the programs provide manufacturers with opportunities to adopt enabling technologies and up-skill their workforces. They can do this by developing and applying additive manufacturing processes in

Program 1 (led by Professor Milan Brandt at RMIT), which will be enabled and enhanced with automated and assistive technologies in **Program 2** (led by Dr Peter Kambouris at CSIRO), leading to the design and development of high-value products, which is the focus of **Program 3**

(led by Professor Stan Skafidas FTSE at The University of Melbourne).

Manufacturing competitiveness is a function not of a single factor, but of a structured and purposeful interaction of strategy, leadership, technological excellence, and enterprise and value chain organisation and culture. To maximise impact, IMCRC combines the technical with the organisational and strategic imperatives.

Program 4 (led by Mr Lance Worrall at The University of Adelaide), ensures this integration, and a close interface with end-users. It is the vehicle for maximising end-user involvement in the uptake and diffusion of new technologies and business innovation.

The current programs in IMCRC reflect some of the key opportunities where research can create an impact for participants:

- **Program 1** – focuses on additive manufacturing reflecting the need to test whether and how Australian businesses can fully exploit the potential offered by one of the fastest moving technological trends today.
- **Program 2** – the rise of automation globally demands that our firms not only keep up with how businesses can use automation to be more productive and effective, but how we can use automation to assist rather than necessarily replace human workers.
- **Program 3** – focuses on high-value product development reflecting the fundamental need for Australian manufacturing firms to continue moving up the value chain but having the capacity and capability to be fast and agile in order to be competitive.
- **Program 4** – the cross-cutting focus on industry transformation seeks to equip Australian manufacturers with new ways of operating and advanced



A bone-specific implant developed by RMIT's Advanced Manufacturing Precinct with Professor Peter Choong at St Vincent's Hospital in Melbourne.

business models that will help them become more competitive in the future.

IMCRC has a unique opportunity to be truly innovative, not only in leveraging the research partnerships between industry and research providers to develop new technologies and processes, but to foster an increasingly connected and collaborative innovation ecosystem in Australia.

Strong collaborative partnerships are also fundamental to successful translation of research into practice which is, after all, one of the most important aspects of undertaking the research in the first place.

And of course, the CRC will help develop a skilled and technologically relevant workforce that will be essential for knowledge and skills translation into practice. This is vital if we are to build the absorptive capacity of participating firms to maximise the uptake of research from the CRC.

Fundamental to the success of this CRC will be the quality and sustainability of collaborative partnerships that are formed between participants. Building strong partnerships requires mutual understanding of expectations as well as a genuine desire to succeed together for the sake of building a better future for the country.

The aim of the IMCRC will foster strong and sustainable relationships in a number of ways, including the implementation of an industry portal, which aims to become an inclusive means of disseminating knowledge broadly and establishing connections between industry and researchers.

The description of the programs and aims in the article contain extracts from the IMCRC proposal, and rely on input from a big team of co-authors.

PROFESSOR CALUM J. DRUMMOND FTSE is a newly elected Board Member of the IMCRC. He is RMIT Deputy Vice Chancellor and Vice President, Research and Innovation. He has a strong interest in and passion for the commercialisation of research outcomes. He joined RMIT University in 2014 from CSIRO, where he was Group Executive for Manufacturing, Materials and Minerals. Immediately prior to this CSIRO Group Executive appointment, he was Chief of CSIRO Materials Science and Engineering. In the Group Executive and Chief roles (2006–14) he oversaw one of Australia's largest IP portfolios and the CSIRO SME Engagement Centre.

PROFESSOR SWEE MAK is the Director of the RMIT Design Research Institute. He was formerly Director of the CSIRO Future Manufacturing National Research Flagship and before that Deputy Chief – Industry of CSIRO Materials Science and Engineering. He was a member of the IMCRC development team.

The future is Nao with QUT's robots

QUT's roboticists and their fleet of Nao (pronounced 'now') robots are pioneering a new method of programming machines – one in which any person can speak commands that a robot can understand and act on.

It's called natural language programming and QUT roboticist Professor Jonathan Roberts believes it is a key to bringing robots into everyone's world – be they serving customers or helping seniors live independently.

"If we want our robots to truly help us in the home and workplace then all of us will require the ability to instruct them. Just as the Jetson family could tell their robot housekeeper what to do, natural language programming will allow anyone to instruct a robot to do almost anything just by speaking to them."

Robotics PhD student Gavin Suddrey is pioneering the research that will make natural language programming a robotic reality. His passion is aged care and he sees a future in which humanoid robots like Naos will perform the simple tasks around the house that allow the elderly to live independently in their homes for longer.

"My research is centred on developing a system where you teach a robot a task by literally talking them through the steps involved

in much the same way as you might teach a toddler."

Even the simplest human tasks can be broken down into a series of sub-tasks that combined become a complex process for a robot to learn.

QUT is participating in the newly funded Innovative Manufacturing CRC. One of its research programs will focus on the applications of robotics in manufacturing industries and workplaces.

According to Professor Roberts, natural language programming will pave the way for robots in work environments with humans and where the tasks are constantly changing. "The combination of natural language programming and robotic vision – using cameras to see and interpret the world as we do – is really the holy grail of an effective robotic workforce."

QUT's Naos are already recruiting that future human workforce.

"The robotics revolution is going to spawn whole new industries and careers we haven't even dreamed of yet," Professor Roberts says.

"The world will need millions of highly skilled humans to design, develop, direct and maintain our robotic co-workers. Our Naos are a key STEM education tool to get that future workforce comfortable working with robots, programming robots, inspired by robots."



This pint-sized android is helping prepare us for a world with robots.

WOMEN IN TSE

NASA scientist urges space participation

The first female and first Australian principal investigator to lead any mission to Mars has warned that Australia is missing a golden opportunity to inspire – and retain – the next generation of home-grown scientists, engineers and technologists.

She says Australia should join the nations involved in space exploration – at least as a way of keeping our brightest minds at home.

Brisbane astrobiologist and co-leader of NASA's Mars 2020 Rover mission, Dr Abigail Allwood – visiting the Queensland University of Technology to accept an Outstanding Alumnus Award – said Australia's limited involvement in space exploration belied its potential capability.

"More broadly, the lack of opportunities to pursue basic research in general is forcing many of our brightest minds overseas," said Dr Allwood, who grew up in Brisbane and graduated in geoscience from QUT.

"With precious little research funding, loss of CSIRO jobs, and the disappearance of clever industries, we lack domestic inspiration for young Australians to pursue science, technology, engineering and mathematics (STEM) careers.

"Space exploration is one of the greatest sources of inspiration for young minds. Australia doesn't need to be on the sidelines here as other nations take up the challenge. We could be participating in numerous ways, putting an Australian flag in the space news.

"We have fantastic science and engineering education but, for many of us who graduate, the best or only opportunities are overseas. Our country may never reap the benefits of these hard-won assets.

"The best source of inspiration for young Australians to pursue STEM careers would be the promise of a really cool STEM job, here in Australia."

Dr Allwood is Mars 2020 mission's Principal Investigator for the Planetary Instrument for X-ray Lithochemistry (PIXL) she developed, one of seven sophisticated scientific instruments chosen by NASA to be packed onto its next Rover robot.

The Rover's mission is to search Mars for signs of past life. If it finds evidence, Dr Allwood's machine will play a lead role in that discovery. Operated remotely by her team back on Earth, PIXL will analyse the chemistry of Martian rocks at the scale of sand grains, in far finer detail than was previously possible.

GOVERNMENT PROFILES WOMEN IN BUSINESS

Australian women are increasingly becoming business operators, perhaps to improve their family's social and economic wellbeing, remain attached to the labour force and better manage their work-life balance, according to a new government report.

Thirty-four per cent of Australia's business operators are women and numbers are rising, according to *A Profile of Australian Women in Business*, published by the Department of the Prime Minister and Cabinet.

The report profiles Australian women business operators to enable a better understanding of the changing role of this pathway of employment for women. A wide range of data has been gathered for the first time to present a national picture of these women's personal, family, business and employment characteristics.

The report shows the ways in which women who run their own businesses differ from male business operators, and from female and male employees. It examines the reasons women establish their own businesses, and notes some of the barriers to women's employment in general and starting a business in particular.

CHERYL PRAEGER JOINS WA HALL OF FAME

The University of WA's Professor Cheryl Praeger AM FAA, has been announced as the 2015 inductee into the WA Science Hall of Fame

Professor Praeger was honoured for her outstanding contributions to the field and her work encouraging the involvement of women in mathematics.

As Australia's most highly cited pure mathematician many of her algorithms have been incorporated into powerful computer algebra and transformed the way in which algebra is taught and researched. She was only the second woman in Australia to be appointed a Professor of Mathematics.

In thanking the WA Science Awards Committee "for choosing a mathematician" to join the WA Science Hall of Fame she said she was humbled by the honour.

"Science, technology, engineering and most business initiatives require increasingly sophisticated mathematical understanding. Our kids will need confidence and appropriate training to be proficient in the mathematical skills they will need for their future careers, no matter what they may be.

"Remaining at the cutting edge of new mathematical research is the best insurance WA can make to ensure that it is ready to meet future challenges – whether these are to face possible climate change, or manage large data sets, or understand the huge discrete mathematical structures my work focuses on."

Previous inductees include Professor Alan Robson AO FTSE (2014), Professor Lyn Beazley AO FTSE (2013), Professor Stephen Hopper AC FTSE (2012), Dr Bernard Bowen AM FTSE (2011) and (the late) Emeritus Professor John de Laeter AO FTSE (2008).



Cheryl Praeger

WOMEN IN TSE

Four women win L'Oréal–UNESCO Fellowships



Jodie Rummer



Muireann Irish



Shari Breen

The winners of the 2015 L'Oréal–UNESCO For Women in Science Australia and New Zealand Fellowships are studying sharks, future memories, heavy stars and climate change.

The Australian Fellows are: marine biologist Dr Jodie Rummer, from James Cook University, Townsville, who swims with sharks for her research; cognitive neuroscientist Dr Muireann Irish, from the University of NSW, Sydney, who has discovered the importance of future memory in daily life and dementia; and astronomer Dr Shari Breen, from Sydney, who works with CSIRO's National Telescope Facility and drives The Dish at Parkes. The inaugural New Zealand Fellow is geologist Dr Christina Riesselman, from the University of Otago, Dunedin, who is studying past and future climates.



Christina Riesselman

The \$25,000 Fellowships were presented in September in Sydney. The awards were the 9th annual L'Oréal–UNESCO For Women in Science Australia Fellowships and the first L'Oréal–UNESCO For Women in Science New Zealand Fellowship.

The Fellowships have become the pre-eminent award for early-career women in science in Australia and New Zealand, and past Fellows have continued their research to establish themselves as science leaders and science advocates, including 2008 Laureate and Nobel Prize winner Professor Elizabeth Blackburn AC FRS FAA.

STILL FEWER WOMEN IN LEADERSHIP POSITIONS

Men continue to hold the majority of Australia's top leadership positions according to new Gender Indicator figures released by the Australian Bureau of Statistics (ABS). This includes senior positions of non-public-sector employers, the judiciary, federal and state parliamentarians, and managers in the Australian Public Service.

Gender Indicators, Australia brings together a variety of ABS and

non-ABS data, and explores the differences between men and women in society and how these differences are changing over time.

"In 2013-14, just 26 per cent of Key Management Personnel, 24 per cent of Board Directors and 17 per cent of CEOs were women," said Ms Lisa Conolly from the ABS. "Latest data also shows 35 per cent of Commonwealth justices and judges and 23 per cent of all State Supreme Court and Court of Appeal judges were women.

"The Health Care and Social Assistance (37 per cent), Education and Training (36 per cent) and Administrative and Support Services industries (21 per cent) recorded the highest proportions of women CEOs, while there were very few in the Mining (three per cent) and Financial and Insurance Services (four per cent)."

The figures showed situation in the public service was changing, with the proportion of women in senior executive roles rising from 31 per cent in 2004 to 40 per cent in 2014. And in 2015, 31 per cent of federal parliamentarians were women, up from 26 per cent in 2005.

Career-wise, women made up 42 per cent of the professional, scientific and technical services industry, 70 per cent of persons in education and training, 78 per cent of the healthcare and social assistance industry and 49 per cent of the public administration and safety sector.

When it comes to reward and recognition in our society, women also received far fewer nominations than men for the Order of Australia, *Gender Indicators, Australia* noted.

"Historically, less than one in three nominations go to women, and again in 2015 they received 500 nominations compared to 1110 for men.

"The difference is greatest at the highest tiers of the honours system, where around three times as many men receive either the Companion of the Order (AC) or Officer of the Order (AO) award in the General Division."

In 2015, 756 men and 377 women received a General Division Order of Australia award at either the Australia Day or Queen's Birthday announcements. Two women received the highest honour (AC), compared to 11 men, while 22 women and 61 men received the second highest honour (AO).

ATSE IN ACTION

ATSE backs program to boost women in science

More than half of Australian universities, along with other science organisations, have joined an ATSE-backed pilot program to improve the promotion and retention of women and gender minorities in science and technology.

The Science in Australia Gender Equity (SAGE) pilot program – a partnership between the Australian Academy of Science (AAS) and ATSE – will be the first Australian trial of the successful UK Athena SWAN gender equity accreditation program.

More than 30 organisations – including universities, medical research institutes and CSIRO – will participate in the pilot, which was launched at Parliament House, Canberra, in September by the Chief Scientist, Professor Ian Chubb AC FTSE.

The program rates the gender equity policies and practices of participating

organisations with a gold, silver or bronze award and helps them to develop ways to promote and retain women and gender minorities in their organisations.

The Athena SWAN charter began a decade ago with just 10 universities but has grown today to include as a member nearly every science and technology education and research institution in the UK.

"Most science disciplines are dominated by men in senior positions, despite the fact that roughly equal numbers of men and women study science and start science careers," said Professor Andrew Holmes AM FRS FAA FTSE, AAS President.

"Not only is this inherently inequitable and unfair, the loss of women from science also represents a very substantial cost to Australia in training, talent and opportunities for scientific innovation.

"This is an important initiative of two of Australia's Learned Academies who are working together to address this long-standing problem across the science sector for the first time."

ATSE President Dr Alan Finkel AO FTSE said: "Entrenched problems don't right themselves without a concerted effort to make amends.

"The Athena SWAN initiative will address the fall-off in representation of women in science at senior levels. It is a critically important initiative and ATSE is keen to build on its own achievements in gender equity and looks forward to cooperating with the Academy of Science.

"The take-up by 32 institutions in the pilot program is encouraging and means it will have substantial impact in science and technology fields from the outset.

CLUNIES ROSS AWARDS CLOSING SOON

Nominations for the 2016 Clunies Ross Awards, which opened on 3 August, will close on 30 October.

Fellows are urged to nominate prospective candidates before the closing date and to circulate news of the Awards as widely as possible in their networks. There will be a new format and specific categories for the Awards in 2016.

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

In recognition of the complex nature of such activities, from 2016 the Awards will be made in three categories with a single winner in each category.

The winners will be announced at ATSE's 2016 National Challenge Conference in Sydney in June.

The three award categories are:

- **Clunies Ross Entrepreneur of the Year Award** for those who have been responsible for the creation of a product or service with a financially successful outcome, in either an early stage or mature company environment with demonstrated impact for Australia.
- **Clunies Ross Knowledge Commercialisation Award** for those who have been responsible for a technology which has been commercialised, most likely by licensing, with a financially successful outcome.

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

The award criteria are:

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

The Clunies Ross Awards Selection Committee is chaired by Mr John Grace FTSE, who conducted a review of the Awards last year for the Board. Members of the committee are Mr Wayne Fitzsimmons, Professor Chris Greig FTSE, Professor Erol Harvey FTSE, Dr John Keniry FTSE, Dr Anna Lavelle FTSE, Dr George Morstyn FTSE, Professor Mike Rickard FTSE, Professor Margaret Sheil FTSE and Professor Tom Spurling AM FTSE.

Nomination Guidelines and the Nomination Form are on the ATSE website at [About > Clunies Ross Award](#).

ATSE IN ACTION

PHOTO: AAS/JEN VAN DIJK



ATSE Vice President Susan Pond addresses the SAGE launch.

"ATSE has worked hard to put its own gender equity house in order and has made substantial progress at the highest ranks in recent years. We are pleased to be able to take our established leadership into broader areas to drive a national embrace of the need to optimise our thinking and working capacities, irrespective of gender."

A major contributor to ATSE's SAGE initiative has been Academy Vice President Professor Tanya Monro FAA FTSE, who has contributed substantial funds towards ATSE's share of the SAGE costs from her ARC Georgina Sweet Australian Laureate Fellowship.

Pilot participating organisations are:

- Australian National University;
- Australian Nuclear Science and Technology Organisation;
- Baker IDI Heart and Diabetes Institute;
- Charles Sturt University;
- CSIRO;
- Curtin University;
- Deakin University;
- Edith Cowan University;

- Flinders University;
- George Institute;
- Griffith University;
- La Trobe University;
- Monash University;
- Queensland University of Technology;
- RMIT University;
- SA Health and Medical Research Institute;
- Southern Cross University;
- Swinburne University;
- Telethon Kids;
- University of Canberra;
- University of Melbourne;
- University of New South Wales;
- University of Newcastle;
- University of Queensland;
- University of South Australia;
- University of Sydney;
- University of Tasmania;
- University of Technology Sydney;
- University of Western Australia;
- University of Wollongong;
- Western Sydney University; and
- Walter and Eliza Hall Institute of Medical Research.

INFRASTRUCTURE PLANNING CRITICAL

Effective infrastructure planning is a critical issue for Australia, particularly as our population continues to grow, ATSE says.

Infrastructure is vital for driving productivity, underpinning prosperity and our way of life. Its construction and use impact on all aspects of our society and environment, ATSE says in its submission to the Australian Infrastructure Audit, which it describes as an essential step in planning and delivering the nation's future infrastructure.

ATSE agrees that major reforms are needed to improve the way we plan, finance, construct, maintain and operate infrastructure to ensure it can underpin gains in Australia's productivity in the decades ahead, and contribute to economic growth.

It notes that all of the recommendations outlined in the ATSE Infrastructure Position Statement 'Infrastructure to meet Australia's future needs' also feature as key findings of the Audit, including:

- commit to robust long term infrastructure planning;
- ensure effective infrastructure development and delivery;
- implement best practice, whole-of-life infrastructure management; and
- use existing infrastructure as effectively as possible.

But the Audit raises some important issues that deserve further attention, ATSE says, including:

- the need for more consistent and accurate analysis of infrastructure – to put greater weight behind the findings and enhance the level of trust between communities and governments;
- the benefit of incorporating low-emission energy technologies in energy infrastructure plans, construction methods and operational frameworks;
- the critical need for investment in upgrades and maintenance of existing water assets;
- the priority requirement for development and the implementation of emerging technologies into digital infrastructure; and
- the need to incorporate other key aspects of the economy – such as capacity and capability in waste management, emergency and disaster response, education and research.

ADVANCE QUEENSLAND

Jobs now, jobs for the future

Advance Queensland— a strategic investment in Queensland's future

Image © Queensland Government. Photography by Lime.

Advance Queensland is a comprehensive \$180 million suite of programs designed to create the knowledge-based jobs of the future, drive productivity improvements and build on Queensland's natural advantages. These programs will bring industry, universities and government together to take great ideas, turn them into investment-ready proposals, attract that investment, and create jobs. It comprises three themes:

Investing in our future

- \$50 million **Advance Queensland Best and Brightest Fund** will develop, attract and retain world-class talent, both scientific and entrepreneurial. It includes:
 - A range of fellowships and scholarships
 - Global Partnership Awards to support collaboration between Queensland and international researchers and entrepreneurs
 - Knowledge Transfer Partnerships Program to link industry and universities, promoting the use of research and problem-solving skills to assist business growth.

Translating ideas and research

- \$46 million **Advance Queensland Future Jobs Strategy** will open the door to new industry-research collaborations, tackles the big innovation challenges, focuses on translation and delivers 10-year roadmaps for industries with global growth potential.

Boosting our entrepreneurial culture

- \$76 million **Advance Queensland Business Investment Attraction package** will encourage a new wave of Queensland startups, supports proof-of-concept projects and attracts co-investment through the Business Development Fund.

This is a strategic investment in Queensland's future—get involved in helping bridge the gap between great ideas and the jobs they can lead to.

To find out more about Advance Queensland and how to apply for funding go to  qld.gov.au/advanceqld

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**Queensland
Government**



Business cases key to nuclear investment

Making decisions on investment in nuclear energy should rest on sustainable business cases, ATSE has told the South Australian Royal Commission on the Nuclear Fuel Cycle.

The importance of comprehensive business and economic analyses of nuclear options for energy was a key recommendation in the Academy's 2014 Action Statement, titled 'Nuclear Energy is an Option', which set out a series of recommendations for government, industries and universities to progress nuclear as an energy option for Australia.

ATSE noted that it had proposed for some time that nuclear energy and other aspects of the nuclear fuel cycle should be debated by the Australian community, and the submission said the Royal Commission was a significant development in this regard.

The submission – which followed a meeting between Academy president Dr Alan Finkel AO FTSE and former SA Division Chair Mr David Klingberg AO FTSE with the Commissioner, Rear Admiral Kevin Scarce AC CSC – addressed a number of aspects key to South Australia.

Although fuel processing and fabrication, and the production of electricity from nuclear, were technically feasible in South Australia, there remained a number of legislative, policy and economic conditions that would need to be addressed before any projects in these areas could proceed, it said.

Similarly, nuclear waste management offered potential opportunities for South Australia, subject to a number of conditions. Across all areas, the importance of securing social licence to operate was strongly emphasised.

ATSE's submission built on the solid

body of work by the Academy on nuclear issues over many years, including the ATSE Action Statement on Nuclear Energy, the Communique and report from the 2013 ATSE nuclear conference, and the National Academies Forum (now ACOLA) report on attitudes to nuclear in Australia.

The submission was written with input from a large number of Fellows. Mr Martin Thomas FTSE and Dr Ian Duncan FTSE conducted an initial analysis of the four Issues Papers produced by the Commission, which provided the basis for the ATSE submission, which was reviewed in draft by the Academy's Energy Forum.

The submission is on the ATSE website at [Publications>Energy>Submissions](#)

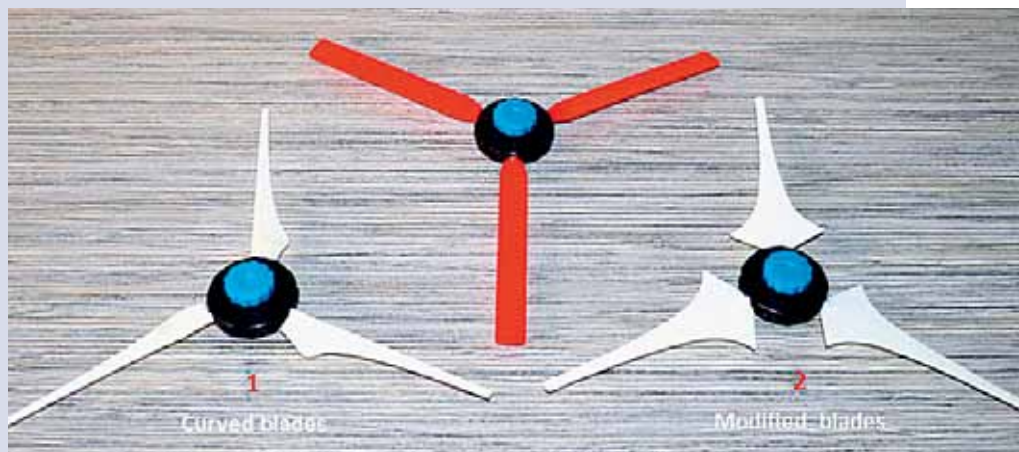
STELR wind energy and 3D printing blades

Many schools now either have their own 3D printer or have access to one. As an extension to the STELR wind energy investigations, ATSE has suggested an additional activity where students can design, print and test their own turbine blades.

Maitland Grossmann High School, in NSW's Hunter Region, is a STELR school that has been running an innovative school-based program to improve career pathways for young people in science, technology, engineering and mathematics (STEM) called 'The ME Program'. It integrates the traditionally separated STEM subjects in an environment that utilises higher-order problem-solving strategies and employs emerging technologies such as robotics and additive manufacturing.

Teacher Scott Slep has been using STELR Renewable Energy resources since 2011 and, as part of The ME Program, has developed an assessment task for his students where they design and manufacture turbine blades for the STELR turbine hub. He has generously allowed ATSE to share his assessment task with other STELR schools who may wish to do the same.

At Scott's suggestion, one of his Year



The two printed blades with the original STELR blade.

10 students provided us with two designs for alternative turbine blades – 'modified' and 'curved'. Both were 3D printed in ABS (acrylonitrile butadiene styrene).

STELR staff tested the designs by comparing the voltage produced by each one compared with STELR's usual long, red turbine blades. The 'modified' blades performed considerably worse, producing around 2V compared with 4.5V from the STELR red turbine blades. But the 'curved' blades (once positioned optimally) performed

considerably better, generating up to 6V.

A video of the performance of the curved blades is available on the STELR website.

To assist teachers and students with their blade design, the technical specifications of the STELR turbine blade have been provided to schools, allowing them to copy the blade base so that the design will fit into the STELR hub. A copy of the 3D printer design file (.stl file) for the 'curved' blades is also available for STELR schools on request.

ATSE IN ACTION

'Vision for a Science Nation' consultation paper

ATSE's response to the 'Vision for a Science Nation' consultation paper, which is the Government's response to the Chief Scientist's paper 'STEM: Australia's Future', canvases a number of initiatives and policies (both in train and proposed) that the Government could pursue.

Each would meet the recommendations from the Chief Scientist's paper, across four major themes:

- competitiveness;
- education & training;
- research; and

■ international engagement.

ATSE's response welcomed the Government's intention to develop a whole-of-government integrated policy, which was the key recommendation from ATSE's 2013 Science & Technology Policy Statement. ATSE strongly recommended that this policy include an overarching vision to connect the various programs, initiatives and agencies that work across science, research and innovation.

ATSE also offered some specific comments on the elements canvassed in the paper, including support for a review of the role of the

Innovation Australia Board, strong support for initiatives to improve collaboration between researchers and businesses (such as ATSE's Research Engagement for Australia (REA) metric) and reiterating the importance of improving STEM education and teaching (through programs such as STELR).

A group of Fellows is currently reviewing the 2013 S&T Policy Statement, with a view to producing an overarching vision or master plan for innovation in Australia. More information will be provided to Fellows as this develops.

The response to the consultation paper is attached and can also be found on the ATSE website at [Education>Vision for a Science Nation Consultation Paper](#)

Wonder of Science moves to UQ

The Academy has passed management of and financial responsibility for the Wonder of Science program to the University of Queensland, where it is now housed in the Diamantina Institute.

The Wonder of Science program, established by ATSE's Queensland Division, is an education program that provides authentic science inquiry opportunities for Years 5 to 9 students in regional, rural and Indigenous communities across Queensland.

Wonder of Science was launched in 2012 as a pilot program with generous sponsorship from Queensland industry and university partners. It aims to work with some 2000 students this year through a multi-faceted delivery model that includes

investigative science projects, visits to schools by university students serving as Young Science Ambassadors, and support for teachers.

"Our sponsors have played a huge role in our ability to serve as many children as we have," Program Manager Ms Robyn Bull says. "I wish I could take them into the classroom to personally show them what a difference their funding makes. The transformation some of these students go through is amazing to see."

According to the Office of the Queensland Chief Scientist, job growth in STEM areas has been strong over the past decade, yet the number of students undertaking science and maths in secondary schools has declined. This has impacted Queensland's university science enrolment rates, which are well below the

national average.

UQ Diamantina Institute's existing SPARQ-ed program is primarily geared to students in Years 11 and 12. Wonder of Science, which will be delivered in partnership with Queensland University of Technology and the Translational Research Institute, will provide a continuum of learning that aims to help ensure a more sustained STEM experience.

"As a research institute, we think the future of Queensland's economy depends on students with a solid background in science," says Institute Director Professor Matt Brown. "We are keen to help provide children with first-hand experiences of modern science from an early age, and wherever in Queensland they may live."

ACOLA LAUNCHES TWO REPORTS

The Chief Scientist, Professor Ian Chubb AC FTSE, launched the SAF08 Report, *Delivering sustainable urban mobility*, at Parliament House, Canberra, in October.

Part of the Securing Australia's Future (SAF) project, Dr Bruce Godfrey FTSE, chair of the ATSE Energy Forum, chaired the Expert Working Group for SAF08.

The study was informed by the fact that Australia is one of the most urbanised nations in the world, with almost two-thirds of the population concentrated in five metropolitan areas and projected urban expansion, and the residential expectations of many Australians, are raising acute questions relating to the planning and provision of social, economic and physical infrastructure, with mobility and accessibility at the centre.

The report looks at optimising the transport system for lower emissions within and between innovative urban infrastructures, and examines effective ways to counter the institutional and cultural obstacles to transformational change.

ACOLA launched the SAF05 Report at Parliament House in September – also with Professor Chubb officiating.

Technology and Australia's Future examined the risks and opportunities of a broad range of new and emerging technologies, and evaluated their transformative implications for Australia's society, democracy, environment, security and trade.

Professor Rob Evans FAA FTSE chaired the Expert Working Group, which also included Professor Ron Johnston FTSE and Professor John O'Callaghan.

ATSE IN ACTION

ATSE backs new WA science councils

The Academy is supporting the endeavours of Professor Adrian Egan FTSE to develop the new South West Science Council in WA, which aims to connect various groups and individuals to foster scientific innovation within the region.

The council, which is in the process of being incorporated, was set up by Bunbury-based Professor Adrian Egan to link people from different fields in the region and put science on the map.

"The idea came to me that from the background I had in agriculture and environmental science and my interest in the agricultural industries particularly down here – dairy, beef and horticulture," Professor Egan said.

"From that kind of background, I thought there are a lot of people around who don't actually appreciate how much science and technology are involved in everything we do every day and everything we expect to happen in the future."

Professor Egan said the Council – supported by WA's Scitech and ATSE – comprised a steering committee of 12 representatives from organisations including Dolphin Discovery Centre, South West Institute of Technology, Edith Cowan University and South West Catchments Council.

Once the council was incorporated, members would have access to a huge network throughout the South West area of the state and could draw on expertise from people in other fields to determine the most effective methods and processes to complete projects.

"The whole idea of a South West Science Council is that it advocates and showcases, in relation to change that has been brought in, where people have used the science and the technology to take their business to another level," he said.

The Council participated in two Science Week events in Bunbury – the STEM Fair at Newton Moore Senior High School and the Light the Future Science Show.

South West Catchments Council senior scientist and Council Deputy Chair Emily Hugues-dit-Ciles said the science council gave the catchments council the opportunity



Adrian Egan explains the SWSC.



Under the ATSE banner – Professor Karl Kruszelnicki (second from left) and Professor Lyn Beazley (right) at Light the Future.

to link with other fields of science to implement holistic, integrated natural resource management practices.

"Links with other industry is critical to open opportunities to improve our South West environment and sustainable agriculture," Ms Hugues-dit-Ciles said.

The first initiative of the Council will be to establish a hub for the national education program Inspiring Australia, where Professor Egan said the council's volunteer members would mentor students on the links between their knowledge and its application in economic, environmental and social causes.

In another initiative, Professor Phil Cocks FTSE is chairing another regional science council – The Great Southern Science Council, which consists of seven active or retired scientists with an interest in science in the Great Southern Region of WA.

Established in 2011, it acts as an advocate and independent voice for science, through education and engagement initiatives, to foster a culture of science and strengthen partnerships for effective collaboration in the Great Southern.

The Council sponsors a one-day seminar in most years, giving local scientists and scientists with an interest in the region an opportunity to present to the community and fellow scientists an overview of their research. It has a special interest in encouraging students at local secondary schools and has presented Science Rocks, where scientists from many disciplines present brief talks suitable for Year 9 and 10 students.

Both Councils receive support from the WA Division and from the former WA Chief Scientist Professor Lyn Beazley AO FTSE.



The DVG peripheral.

DSTO's DVG protects against cyber threats

DSTO scientists have developed a unique computer security device that provides protection against cyber intrusion.

The Digital Video Guard (DVG) is a small peripheral that allows internet transactions, content and applications to be secured when using untrusted computing infrastructure by decrypting, verifying the integrity of, and displaying content independent of the computing infrastructure being used.

The DVG is installed between a host computer and an external digital display and allows the contents of a known video signal to be trusted. The device displays a 'trust' indication – via an integrated LED – to the user to indicate that the DVG is operating and the integrity and confidentiality of the displayed information is intact and reliable.

While developed with the defence of Australia in mind, the device can be used to secure content delivered over untrusted networks for the banking and finance and medical industries.

The biggest threat to internet banking is the loss of log-on details, which occurs predominantly through keystroke loggers or phishing attacks where a user is redirected to a fake log-on screen. The DVG protects against these attacks and secures log-on details, account information and authorisation of transactions.

The DVG can also be used to secure content sent via email or instant messaging applications. By sending an encrypted image within a normal email, a DVG can protect the confidentiality of the email. This is particularly useful when using an internet café or untrusted computing equipment.

A key feature of the device is that it can be adapted to operate with desktop, laptop or embedded directly into tablet devices.

NICTA MERGES WITH CSIRO TO BECOME DATA61

The Government claims that one of the largest digital innovation teams in the world will be created when CSIRO's Digital Productivity flagship and NICTA merge.

Researchers from the two organisations will come together to form a new CSIRO entity called Data61, led by Australian technology entrepreneur Mr Adrian Turner.

"CSIRO and NICTA are two world-class research organisations with some of the world's leading scientists," said the former Minister for Industry and Science, Ian Macfarlane, announcing the merger.

"Both have an impressive track record in digital innovation and have demonstrated their ability to take home-grown technologies to market.

"Together they will be a force to be reckoned with, creating an internationally recognised digital research powerhouse that will benefit

Australian industry as it reaches into new global markets and seizes new opportunities for jobs and growth."

"Having a single national organisation will enable Data61 to produce focused research that will deliver strong economic returns and ensure that Australia remains at the forefront of digital innovation," former Communications Minister Malcolm Turnbull said.

Mr Turner said he was joining CSIRO at an exciting time. His vision for Data61 was to harness the start-up culture of NICTA and multidisciplinary strength of CSIRO to deliver maximum benefit to Australia.

For the past 18 years, Mr Turner has been based in Silicon Valley, firstly working for global tech giant Phillips then building his own companies. Mr Turner was formerly Managing Director and Co-Founder of the Borondi Group, a company that applies emerging technologies in traditionally conservative industries such as agriculture, mining and transportation.

ADF UPGRADES BATTLEFIELD COMMS

The Government has signed a significant contract for an upgrade to the next generation of military communications for the Australian Defence Force. The contract with Boeing Defence Australia is expected to create around 250 new jobs across Australia in the defence industry sector.

The contract, valued at \$665 million, will see Boeing design, develop and deliver a modern, digital communications system to support the deployment of operational headquarters and enable access to Defence's strategic networks. It will replace ageing mobile communication systems and computer networks, providing "leading-edge digital wideband voice, data and video services over wireless and wired infrastructure" and enabling more effective operations.

The contracts will be managed from the Boeing Defence Australia Brisbane facility and include subcontracts with Harris Communications Australia and GH Varley. Initial operational capability is expected in 2017, with final operational capability in 2020.

SAMSUNG AND QUESTACON BACK 'DEVICE' SCIENCE

A new technology partnership between Questacon and Samsung Electronics Australia, helping students understand the transformative science behind smart tablets and smartphones, has won support from the former Parliamentary Secretary for Industry and Science (and new Assistant Minister for Science) Mrs Karen Andrews.

The three-year, technology partnership between Questacon (the National Science and Technology Centre) and Samsung will support the Questacon Smart Skills program in regional areas across Australia.

"The really exciting thing about this program is that kids can take everyday technology and transform it into a powerful tool to fire their imagination," Mrs Andrews said. "They'll learn how to do things they probably haven't even thought of – by designing, prototyping, controlling and testing model cars, rockets and bridges in the Smart Skills workshops."

Mrs Andrews said the partnership would support the national delivery of the Questacon Smart Skills program in workshops for students and teachers. "The workshops will be important for the students, but are equally important for teachers because they introduce innovative ways to confidently incorporate technology into their teaching, creating a powerful legacy in that classroom for years to come."

We need to reverse 20-year maths trends

Australia's future as a high-technology, research-driven economy will depend on reversing 20-year trends in the mathematical sciences, according to a new report by the Australian Mathematical Sciences Institute (AMSI).

AMSI has released its fourth annual *Discipline Profile of the Mathematical Sciences*, which paints a mixed picture of Australian engagement with the mathematical sciences.

It notes that 86 per cent of science degrees do not have intermediate mathematics as an entry prerequisite – and maths prerequisites for entry into science, commerce and engineering degrees are at historic lows.

AMSI Director Professor Geoff Prince insists: "Universities must phase in restoration of maths prerequisites; the lack of them sends a negative and misleading message to schools about the value of these subjects."

It also notes that at least 30 per cent of Year 7 to 10 maths classes are taught without a qualified maths teacher – more than double the international average – and says Australia needs to know why potential educators aren't choosing to be maths teachers.

The report says women make up only 30 per cent of undergraduate maths enrolments, which is inadequate and is holding back our STEM workforce and productivity growth.

Maths' multi-billion-dollar value to the economy is under threat as the maths PhD rate stagnates, the report says.

"Governments are trying to drive up business employment of STEM-trained research professionals, however, domestic PhD numbers in the mathematical sciences are among the very lowest in the OECD," Professor Prince says. "Universities and businesses must improve engagement to maximise the economic benefits of mathematics and statistics."

Discipline Profile of the Mathematical Sciences is accompanied by a policy document, *Vision for a Maths Nation*, which identifies four key priorities to reverse these confronting trends:

- 1 Restore university maths prerequisites from their historic low and turn around declining school mathematics enrolments.
- 2 Train the unqualified teachers of school mathematics and secure the supply of future qualified maths teachers.
- 3 Increase the number of girls studying maths and women employed in the quantitative professions.
- 4 Boost the engagement of Australian business with mathematical sciences research.

DOUBLE DEGREE IN SCIENCE AND TEACHING

The Australian National University (ANU) and the University of Canberra (UC) have joined forces in a unique collaboration to help students kick-start their careers in science teaching.

For the first time, from 2016 the two universities will offer a vertical double degree for science teaching, combining a Bachelor of Science (BSc) from ANU with a Master of Teaching (MTeach) from UC.



Geoff Prince

ANU Vice-Chancellor Professor Ian Young AO FTSE and UC Vice-Chancellor Professor Stephen Parker AO said the new double degree flipped the process of teacher education by allowing students to specialise in science first, and then develop their teaching skills.

Professor Young said the new vertical double degree would help improve careers and standards for teachers in the crucial areas of science, technology, engineering and maths (STEM).

"This new vertical double degree will give students a new pathway into science teaching by giving them access to outstanding qualifications in two specialist areas in a shorter time, and at a lower cost," Professor Young said.

Professor Parker said the collaboration between the two universities would allow greater choice for students wanting to study science and teaching together. "This unique collaboration will give students the best experience of both universities, by providing them with access to Australia's best science and teaching-education facilities," he said.

ANU HEADS AUSTRALIAN QS RANKINGS

The 2015-16 QS World University Rankings list 33 Australian universities, seven of which rank within the global top 100, while a further 10 are in the top 300.

The Australian National University heads the field as Australia's top-ranked university, sharing 19th place in the world rankings with King's College, London. The University of Melbourne was ranked second (and 42nd in the world), while Sydney University took third place (45th in the world).

UNSW and UQ shared fourth spot in Australia and 46th in the world, followed in sixth place (and 67th in the world) by Monash University, The University of Western Australia (seventh and 98th), the University of Adelaide (eighth and 113th), the University of Technology Sydney (ninth and 218th) and Macquarie University (10th and 229th).

Others were the University of Wollongong (11th and joint 243rd), University of Newcastle (12th and 256th), QUT (13th and joint 263rd), RMIT (14th and joint 273rd), Curtin University (15th and joint 284th), University of South Australia (16th and 288th), Deakin University (17th and joint 324th), Griffith University (18th and joint 329th), University of Tasmania (19th and 379th), James Cook University (20th and joint 387th) and La Trobe University (21st and joint 394th).

The balance of the 33 Australian universities ranked were Bond (22nd and 501-550), University (23rd and 501-550), Swinburne (24th and 501-550), Charles Darwin (25th and 551-600), Murdoch (26th and 551-600), Canberra (27th and 551-600), Victoria (28th and 601-650), New England (29th and 651-700), Western Sydney (30th and 651-700), Charles Sturt (31st and 701+), Edith Cowan (32nd and 701+) and Southern Queensland (33rd and 701+).

Massachusetts Institute of Technology (MIT) retained the top spot for the fourth year running, with Harvard University climbing two places to rank second, followed by the University of Cambridge and Stanford University in joint third. The remaining top 10 were (in order): California Institute of Technology, Oxford University, University College London, Imperial College London, ETH Zurich and the University of Chicago.

Outside the top 10, The National University of Singapore ranked 12th worldwide, while Singapore's Nanyang Technical University took 13th place.

A total of 82 countries were represented, with the largest share or the rankings claimed by the US (154), UK (71), Germany (43) and France (41). Japan had 38 entries, Australia 33, China 30, Canada and Italy 26 apiece, Brazil 22 and Russia 21.

Marine science plan to guide 'blue economy'

The marine science community has produced a 10-year plan to guide Australia's marine science efforts and help maximise value and manage the growth of marine industries.

"Tourism, shipping, oil and gas, aquaculture and fishing all rely on our oceans, and the contribution of marine-based industries to our economy has doubled in the past decade to around \$47 billion," said former Industry and Science Minister Ian Macfarlane.

"As this growth continues, we need to make the right investment and management decisions now to secure balanced benefits in the future.

"This will ensure strong stewardship of the unique marine environments within our 13.86 million square kilometre ocean jurisdiction, which is the third largest in the world.

"The plan examines how Australia's marine science capabilities can be leveraged to support the sustainable development of the blue economy.

"The National Marine Science Plan (NMSP) outlines the research knowledge and capabilities needed for a better understanding of Australia's vast marine estate, its ecosystems and resources.

"This plan presents a way forward for both science and industry to ensure our ocean ecosystems bring economic, cultural and social benefits that are efficient, equitable and sustainable."

Parliamentary Secretary (now Assistant Minister) Karen Andrews said the plan (available on the Fisheries R&D Corporation website) was developed by the National Marine Science Committee, which includes Australian Government agencies and representatives from State and Territory governments and university marine science bodies.

"This plan has brought together our marine science community in

a broad consultation process that involved more than 500 scientists and stakeholders," Mrs Andrews said.

"The plan sets out the seven most significant development and sustainability challenges, including food and energy security, protecting biodiversity, sustainable coastal urban development, climate variability, and marine sovereignty and security."

Australian Institute of Marine Science CEO and Chair of the National Marine Science Committee, Mr John Gunn FTSE, welcomed the NMSP.

"Oceans are critical to our planet and the country's future as they are key drivers of climate and weather and this Plan outlines the science needed to provide the knowledge, technology and innovation cornerstones that will grow a sustainable blue economy.



The National Marine Science Plan

Australia's marine science institutions include the Australian Institute of Marine Science, the Bureau of Meteorology, CSIRO, the Defence Science and Technology Organisation, the Fisheries Research and Development Corporation, Geoscience Australia and universities.

"The NMSP is a call to action to the nation's marine scientists, but also to all those who will benefit from a strong marine science sector that is dedicated to working with governments, industries and communities in the mission of ensuring that we get the most out of our marine estate while protecting the things we all care about," he said.

ABARES NOTCHES UP 70 YEARS' RESEARCH

The Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) has, in its various forms, completed 70 years of applied research in Australian agriculture, fisheries and forestry.

Established in August 1945, as the Bureau of Agricultural Economics (BAE), among its original functions was to investigate "the economic prospects of primary industries with particular reference to efficiency factors".

A key activity has been its farm surveys program, expanding to cover broadacre and dairy industries on an annual basis since 1971 and other industries when requested. Information from the farm surveys has provided a rich time-series of data on which to base analysis of farm performance and productivity.

A number of related research agencies were combined to form the Australian Bureau of Agricultural and Resource Economics (ABARE) in 1988. This expanded the research focus to include energy and minerals markets, as well as major issues such as climate change, where the bureau was recognised internationally for its analytical leadership.

ABARE also contributed to domestic debates on natural resource management, including reforms to water policies, development of regional forestry policy and changes to fisheries management.

ABARES was formed following a merger with the Bureau of Rural Sciences (BRS) in 2010, undertaking integrated economic, scientific and social research.

One of the bureau's hallmarks has been its Outlook conferences, where delegates hear the latest trends and information. The first was held in 1971 and within a decade expanded to include regional conferences. They are now recognised as Australia's leading agricultural economics forum.

CSIRO BUYS NEW RESEARCH FARM

CSIRO has purchased 290 hectares of land at Boorowa, 116 kilometres north of Canberra, in New South Wales, for its agricultural research program.

CSIRO Agriculture Director Dr John Manners said that CSIRO would continue its world-leading agricultural science from the new farm.

"Establishing a new facility in a rural area allows us to take a green field approach to the site and our science," Dr Manners said.

"This can enable us to conduct research into very new ways of farming, including the application of digital farming technologies. The new site is approximately 100 kilometres from our current site, allowing our Canberra researchers to continue their field trials on the new site."

The Boorowa property will replace CSIRO's Ginninderra property on Canberra's northern outskirts, which has been absorbed by the city's urban spread.

"The Ginninderra site has contributed to major progress in Australian science through the work of our programs in developing novel grains and sustainable and productive agricultural systems," Dr Manners said.

Exoskeleton may help with the load

Defence science and technology researchers have developed a new 'exoskeleton' to help ease the heavy burdens that soldiers carry, which may also have a role in many civilian applications such as firefighting.

Some soldiers carry in excess of 85kg of mission-essential personal equipment – a load that can cause fatigue and injury and affect performance.

The solution has been exoskeletons, but the current generation of powered exoskeletons uses a complex system of rigid linkages and mechatronics.

They are showing real promise in enabling the wearer to lift and move about with very heavy loads but the design and natural movement of the human body tends to battle with the exoskeleton movement, causing a dramatic increase in the user's energy cost when walking with a load.

These systems tend to be heavy (weighing upwards of 35kg), very expensive and power hungry.

Now Defence has developed a simple, lightweight (3kg), fully-passive exoskeleton.

This system uses Bowden cables attached to a rigid backpack frame. The cables run down the back and legs to the base of the boot and transfer approximately two-thirds of the backpack load to the ground. This load force bypasses the user's body, reducing compression forces from the backpack load through the torso and legs.

The development is at a proof-of-concept stage with early testing showing encouraging results. While the technology is being developed around use in the military it may be applicable to many civilian scenarios such as firefighting, trekking and personal load carriage roles that require assistive technology.



The exoskeleton fitted to a mannequin.

repairs and maintenance without having to fly in specialist engineers or mechanics.

The GMR system consists of a helper station and an operator station, which both use a wearable computer with a helmet-mounted camera and a near-eye display. The display provides a shared visual space, allowing the off-site expert to demonstrate what needs to be done using a pair of virtual hands.

According to Mr Andrew Sanderson, Managing Director of TAE, the technology has huge potential to bring down maintenance costs for airlines, particularly those in regional locations.

"In the aerospace industry, costs associated with aircraft downtime are a critical issue," Mr Sanderson said.

"If a plane's not operational, it can cost a company up to \$12,000 per hour. Therefore any technology that makes maintenance easier, and helps bring down repair times is a valuable investment.

"Using the GMR system, it is just like the expert is in the room with you, even if they're in another state or even another country. That means there is no more waiting days to get aircraft back up and running."

According to Dr Marcel Bick from CSIRO's Manufacturing Flagship, technologies like GMR are helping Australian companies create more intelligent industrial environments.

"Robotic and digital solutions are improving operating safety and efficiency for Australian industry. As we have increased access to high-speed broadband, this makes the possibilities even more exciting," Dr Bick said.

"The GMR prototype has already been trialled by Boeing and Aviation Australia. With TAE commercialising the technology, from later this year it will be available to aerospace companies around the world."

As well as boosting efficiency in the aerospace industry, GMR could also be used for a range of other applications.

"We see huge potential for GMR in a number of settings including the general manufacturing, mining, automotive, paper and pulp and rail industries," Dr Bick said. "It could even be used to provide remote medical assistance for field health workers and emergency scenarios."



A CSIRO researcher demonstrating the GMR system.

WEARABLE TECH FOR AVIATION

Commercial, regional and defence aircraft operators should be able to reduce aircraft down-time and maintenance costs by using a new wearable technology that can remotely connect technicians with aviation experts from around the world.

Under a new licensing agreement, Australian aerospace company TAE will commercialise CSIRO's Guardian Mentor Remote (GMR) wearable technology system, making it available to the global aerospace industry.

GMR is hands-free technology that uses a headset and glasses to connect experts with onsite operators so they can provide real-time assistance. This means companies can undertake aircraft and engine

Global action needed on 'toxins without borders'

Billions of tonnes of man-made chemical emissions are now being released each year, with grave potential consequences for human and environmental health, says Professor Ravi Naidu, who heads the CRC for Contamination Assessment and Remediation of the Environment (CRC CARE).

Professor Naidu called for worldwide action – at last month's CleanUp 2015 conference in Melbourne – to prevent a potential wave of disease and ill-health spreading across the world's borders.

"Man-made contamination is now to be found almost everywhere in the world we look – from the upper atmosphere and the highest mountains to the deep oceans, from remote atolls to the Amazonian jungle, from the north pole to the south, to our farmlands and especially our inner cities – which are the most polluted places of all," he said.

"A conservatively estimated 250 billion tonnes of chemical and material emissions are dispersing around the planet on the wind, in water, in soil, in wildlife, in the food chain, in trade goods – and in people themselves.

"Now, more than ever before, we need to see contamination as a global issue – one which affects every region, every country, and each citizen directly and indirectly throughout their lives.

"When it comes to contamination, there are no longer any borders," Professor Naidu said.

There was mounting evidence in the medical science literature of accumulated health impacts related to this contamination, including pandemics of cancers, neurological and mental disorders, reproductive and gender problems and metabolic disorders of the digestive system, he added.

The World Health Organization and UN Environment Programme concluded one death in 12 globally may be linked to this chemical impact on human health, making it one of the world's leading causes of death.

WORLD 'FACING FLOOD OF NEW TOXINS'

The world needs to prepare for a flood of potentially dangerous new pollutants, some of which are just as – or more – toxic than 'traditional' pollutants such as heavy metals, according to an international expert in environmental chemistry.

Dr Susan Richardson of the University of South Carolina told last month's CleanUp 2015 Conference in Melbourne that the new contaminants are already finding their way into the world's rivers, lakes, groundwater and drinking water.

The new toxins arise from sources such as artificial sweeteners, nanomaterials, perfumes, medical drugs, hormones, sunscreens, flame retardants, non-stick coatings, pesticide breakdown products, hospital wastes, and the by-products of detergents, disinfectants and swimming-pool cleansers.

Left undetected and untreated, they can be hazardous to humans, with some already linked to conditions such as cancer, obesity, lower intelligence and infertility, Dr Richardson said.

"The world is no longer dealing with the 'same old, same old' contaminants," she explained. "The list of new ones keeps growing, with ionic liquids and prions being among the most recent."

Ionic liquids are used as 'green chemistry' to replace traditional solvents in cleaning products, but their effects are still largely unknown. Prions – molecules that are highly resistant to disinfection – are known to cause 'mad cow disease', chronic wasting disease in deer and Creutzfeldt-Jakob disease in humans.

Dr Richardson said many new contaminants arise from common household products like cleansers and furnishings, personal care products, food packaging, and the medical and recreational drugs we excrete.

"These products get washed off in the shower or flushed down the toilet and travel to wastewater plants. Some of them become toxic once they react with the chlorine or chloramine with which the water is treated," she said.

"It's bad news because our wastewater treatments, which are designed to remove 'traditional' waste, cannot treat these toxins efficiently. There is no one-size-fits-all way to clean up all of them.

"Meantime, the world needs to become much more aware of these emerging contaminants and actively look for them in our waters. While we may not know the ill effects of some of them, it may be too late to stop those effects once they are unleashed."

HELE PLANTS HOLD THE COAL KEY, SAYS MCA

High-efficiency, low-emission (HELE) coal-fired power plants will ensure coal has a fundamental role to play in the provision of low-cost, reliable energy for decades, according to the Minerals Council of Australia, which says they deliver baseload electricity at a much lower cost than all other energy sources.

It says hundreds of new HELE coal-fired plants are in operation, under construction or planned in Japan, China, Europe and elsewhere in East Asia. These plants operate at much higher temperatures and greater pressures, producing reliable, baseload energy while reducing CO₂ emissions by up to 40 per cent.

The Council proclaims HELE plants as a technical transformation that will "sharply reduce the emissions associated with coal-fired power generation" in a new publication, *Delivering a Low Emissions Coal Future*.

In addition to sharply reduced carbon emissions, these plants reduce all other emissions including particulates to negligible levels, the publication says.

The publication also notes that carbon capture and storage (CCS) technologies are continuing to be rolled out around the world, pointing to the recent launch of the world's first commercial CCS plant at Boundary Dam in Saskatchewan, Canada, which it says has cut CO₂ emissions by 90 per cent.

The publication says coal accounts for 41 per cent of the world's electricity generation and in the past decade the use of coal grew four times faster than renewable energy sources and 50 per cent faster than gas.

Other points made in *Delivering a Low Emissions Coal Future* are:

- the coal industry is Australia's second-biggest export earner, valued at around \$40 billion in 2013-14;
- the Department of Industry and Science projects that Australia's coal exports will boost national income by about \$250 billion between 2014-15 and 2019-20;
- Australia is the world's largest exporter of metallurgical (steel-making) coal and second biggest exporter of coal overall; and
- Australia is forecast to become the world's largest coal exporter by 2017.



Predicting clouds to boost solar energy

An Australian-first solar energy project that uses Cloud Predictive Technology (CPT) to anticipate solar energy output has been launched in Karratha, in Western Australia's Pilbara region, with \$2.3 million in support from the Australian Renewable Energy Agency (ARENA).

The project to supply 1MW of solar energy to the Karratha Airport is being led by renewable energy development company SunEdison Australia and aims to answer questions about how CPT can make solar generation cheaper and more efficient by reducing or eliminating storage requirements.

The project will be connected to the North West Interconnected System, Horizon Power's network servicing WA's Pilbara mining region.

ARENA CEO Mr Ivor Frischknecht said the project could also increase the number of renewable energy projects in north-west WA and beyond.

"It will be the first time cloud predictive technology has been used on a solar PV installation of this size connected to a network," Mr Frischknecht said.

"As clouds can lead to a sudden drop in solar output, commercial solar power generation on a smaller network usually has costly storage requirements to 'smooth out' supply into the grid. Employing CPT reduces the need for this buffer, meaning solar generation can be installed and operated more cheaply."

GOOGLE AND APVI OFFER SOLAR SOLUTIONS

Google has launched a subsidiary called Sunroof in the US, which will be a database of how much sunlight hits buildings, based on Google Maps data, with the purpose of enabling people to make better decisions about installing solar panels.

Google describes Sunroof as a "treasure map" for future green energy, telling you how much of a saving you could make and how long it would take to make back your initial outlay. Sunroof will initially be available in three US cities: Boston, San Francisco and Fresno.

The Australian PV Institute (APVI) has already developed a similar tool, called the Live Solar Potential Tool, which operates in a similar manner, allowing anyone to zoom in on a specific household and then estimate how much energy a given area of the rooftop would be likely to generate with solar panels. It accounts for: solar radiation and weather at the site;

PV system area, tilt and orientation; and shading from nearby buildings and vegetation. The Australian tool was developed by the APVI as part of its Solar Mapping research project, funded by the Australian Renewable Energy Agency (ARENA). It is currently available only in a limited area close to the CBD of each state capital city.

NEW SUPPORT FOR CCS R&D

The Australian Government's \$25 million Carbon Capture and Storage (CCS) Research Development and Demonstration Fund will focus on transport and storage projects. The Fund will address CCS research priorities including subsurface knowledge and mapping, transport infrastructure, whole-of-chain integration, and development of international collaboration and partnerships.

Activities under the Fund will be principally based in Australia to ensure national expertise on transport and storage is expanded and the Fund will also provide support to leverage international expertise.

"Australia has a diverse energy mix, made up of traditional energy sources such as coal, through to gas and renewables. The diversity of this mix will continue to underpin Australia's economic future," said former Industry and Science Minister Ian Macfarlane, announcing the Fund.

"Australia's energy resources are one of our most significant competitive advantages. Just as we are using science to boost our key economic sectors, investment in research for carbon capture and storage technologies will be important as the coal and gas industries continue to develop both for our domestic use and for export."

INLAND RAIL COST ESTIMATE \$10 BILLION

The Australian Government has released the Inland Rail Delivery Plan, which outlines a 10-year construction timeframe to complete the 1700-kilometre project, including some 600km of new track, and puts the cost at \$10 billion. Accompanying the plan is a detailed business case, developed by the Australian Rail Track Corporation.

"This Report and business case provide the information needed to consider how best to build the Inland Rail network to meet the freight challenge of the coming decades – expected to treble along the eastern seaboard to 2030," said Minister for Infrastructure and Regional Development Warren Truss.

"Inland Rail will complement existing road and rail networks and will dramatically boost productivity. Initially, it will provide for 1800-metre-long trains carrying containers stacked two high and, in the longer term, much heavier 3600m-long trains.

"The new freight line will reduce transit time between Melbourne and Brisbane by more than 10 hours – reducing the journey to less than a day. It will remove 200,000 trucks, or 5.4 billion net tonne kilometres of freight, from roads each year.

"For the first time, south-east Queensland will connect by rail to Melbourne, Adelaide and Perth, avoiding the need for freight to transit through the congested Sydney network. Inland Rail will reduce the distance between Melbourne and Brisbane by 200km and carve 500km from the Brisbane to Perth trip."

The Government will now consider the report in the context of the 2016 Federal Budget.



CSIRO masterplan targets better innovation

CSIRO is promoting its new plan to improve Australia's innovation record and help the country respond to global changes and digital disruption.

Australia's Innovation Catalyst, CSIRO's strategy for 2015–20, outlines how it will become a global collaboration hub and help boost the country's innovation performance. It is available on the CSIRO website.

"Australia's prosperity, health and sustainability are closely bound to our capacity for innovation – and CSIRO has a key role to play here," CSIRO Chief Executive Dr Larry Marshall said.

"CSIRO is Australia's largest patent holder. We're the people behind fast Wi-Fi, part of the global team that developed extended-wear contact lenses, designer polymers using RAFT technology and the Hendra vaccine – but this is the tip of the iceberg when it comes to the value we offer the Australian people."

In a novel approach for the 90-year-old science body, it crowd-sourced ideas and suggestions from more than 7000 people including its research partners, staff and the public to help determine the strategy's direction.

"At the core of the strategy is the need for CSIRO to be a catalyst for change and growth in the innovation system in Australia. Innovation is a team sport," Dr Marshall said. "We must form new bonds and collaborate across disciplines, sectors, science and business. That is where profound innovation happens – at the intersection of these areas."

"We must also be asking who our customers are and if we're creating the value they need. We work with businesses, industry, governments and communities and we need to find ways to benefit every Australian."

"To help, we have formed the CSIRO ON program – an initiative to fast-track CSIRO technology and ideas into the market and to get it into people's hands more quickly. This is what we call 'breakthrough innovation', where we will help reinvent existing industries and create new ones."

Part of the push for greater collaboration and coordination by CSIRO will be increased co-location with universities and other research organisations and a greater emphasis on international connections.

COLLABORATION LEADS TO PRODUCTIVITY

Australian businesses that engage in collaborative innovation with research organisations are 242 per cent more likely to report increases in productivity, according to IP Australia.

Despite the clear advantages associated with collaborative innovation,

CSIRO's new strategy will focus on customer challenges. CSIRO's Barbara Sowa at a Nissan factory, where CSIRO helped develop new casting technology.

Australia is falling behind, IP Australia says, with Australia ranked 81 out of 143 countries in 2014 on how effectively we produce returns from research, ideas and institutions.

Among the reasons identified for this was the insufficient transfer of knowledge between the research and business sectors.

IP Australia – the Government agency that administers legislation governing intellectual property – has developed 'Source IP' as a digital marketplace for sharing information, indicating licensing preferences and facilitating contact for IP generated by the public research sector in Australia. It says Source IP aims to make it easier for Australian businesses to access public sector innovation and technology and strengthen the focus on boosting collaboration between science and industry.

The site intends to achieve the following objectives for the public research sector:

- to drive innovation and commercialisation by enabling IP Rights holders to signal their patent-licensing intent; and
- to provide a single source of information to increase understanding of potential collaboration between interested parties to promote innovation and technology specialisation.

The Source IP marketplace is due for release late in 2015.

IP TOOLKIT & INNOVATION MAP LAUNCHED

The Government says its new Australian IP Toolkit for Collaboration will help drive greater collaboration between researchers and business, which is critical to Australia's future growth and competitiveness.

The Parliamentary Secretary for Industry and Science (now Assistant Minister), Karen Andrews, said linking research with industry would allow for better translation of ideas into real goods and services, technologies and life improvements.

"By providing guidance on how to develop partnerships and manage intellectual property, the Government is equipping researchers and businesses with the practical tools that they need to collaborate," Mrs Andrews said.

The Australian IP Toolkit has tools for use in collaboration and transparent model contracts that can be used as a neutral starting point for research collaboration. It also provides tips and case studies.

Mrs Andrews also announced a new online tool – the National Innovation Map – which she said could be used to see how various regions in Australia compared in the innovation stakes.

"Innovation and entrepreneurship often go hand in hand," Mrs Andrews said. "Innovative business activity is influenced by location and proximity to other innovative activity. This map is a great way for Australian business owners to see whether their business is located in a 'high innovation' area."

The National Innovation Map drills down to major, regional and remote areas of Australia and shows:

- new business entry;
- dollars spent on research and development;
- patenting activity; and
- trademarking activity.

ATSE IN FOCUS

Eureka Prize for Tanya Monro

Professor Tanya Monro FAA FTSE, an Academy Vice President, won a 2015 Eureka Prize.

Professor Monro, from the University of South Australia, University of Adelaide and ARC Centre for Nanoscale Biophotonics, teamed with Professor Dayong Jin, UTS, Macquarie University and ARC Centre for Nanoscale Biophotonics, and Professor Bradley Walsh, Minomic International Ltd and Macquarie University, to win the University of NSW Eureka Prize for Excellence in Interdisciplinary Scientific Research.

Professor Martin Green AM FRS FAA FTSE and Dr Mark Keevers, of UNSW, teamed as finalists for the ANSTO Eureka Prize for Innovative Use of Technology. Professor Snow Barlow FTSE, University of Melbourne, was a finalist in the CSIRO Eureka Prize for Leadership in Science.

Professor Monro's award recognised the diverse impact of Super Dots technologies – from non-invasive cancer diagnosis and rapid pathogen detection to invisible coding for authentication of pharmaceuticals, passports and banknotes – which is based on advances in diverse fields: material chemistry, optical physics, nanotechnology, biotechnology, computational modelling and instrumentation engineering.

The Australian Museum Eureka Prizes are the most comprehensive national science awards, honouring excellence in Research and Innovation, Leadership, Science Communication and Journalism, and School Science.

Announcing the Eureka Prize for Excellence in Interdisciplinary Scientific Research, the Museum likened the work to the world's smallest, brightest nano-flashlights finding a diseased needle in a haystack.

"The world's smallest flashlights may be able to light up diseased cells in our bodies. These infected or cancerous cells may be hiding among millions of healthy cells. The Super Dots team has created tiny crystals that can be implanted in the body to reveal the dangerous needle in a haystack," it said.

"The Super Dots team has developed

Tanya Monro



fluorescing nanocrystals that 'switch on' at different times, shining an intense, short burst of light – just tens of millionths of a second – that can reveal any diseased cells.

"By combining physics, chemistry and biology, this research should ultimately allow us to watch the interaction between drugs and

cancerous cells at a molecular level within the patient's body," Ms Kim McKay AO, Executive Director and CEO of the Australian Museum, said.

As well as real-time diagnosis of disease, the technology has potential for creating invisible, lifetime-coded inks that could add 'uncrackable' security to banknotes and passports.

The 2015 Eureka Prize judges included a raft of Academy Fellows including:

Professor Snow Barlow, Faculty of Veterinary and Agricultural Sciences, University of Melbourne; Professor Ben Eggleton, Director, CUDOS ARC Centre of Excellence, University of Sydney; Professor Gustaaf Hallegraeff, Institute for Marine and Antarctic Studies, University of Tasmania; Professor Max Lu, Provost and Senior Vice-President, The University of Queensland; Dr Jim Peacock, CSIRO Fellow and Distinguished Professor, University of Technology Sydney; Professor Judy Raper, Deputy Vice-Chancellor (Research and Innovation), University of Wollongong; Scientia Professor Veena Sahajwalla, Laureate Fellow and Director, Centre for Sustainable Materials Research and Technology, UNSW; and Professor Margaret Sheil, Provost, Professor of Chemistry, University of Melbourne.



SA FELLOWS GET THE MUSEUM LOW-DOWN

SA Fellows got a behind-the-scenes look at the South Australian Museum recently when their visit was hosted by Professor Steve Donnellan, Chief Research Scientist of its Evolutionary Biology Unit. They were able to inspect a great deal of collected material and learn about museum collections.

ATSE IN FOCUS

David Thodey is new CSIRO Chair

Former Telstra CEO Mr David Thodey FTSE has been appointed the new Chair of the Board of CSIRO for the next five years. He will join the board in November.

David Thodey



Mr Thodey was the CEO of Telstra from May 2009 to April 2015. He has been credited with significantly increasing Telstra's share price and doubling the value of the company.

Before joining Telstra, Mr Thodey had a 22-year career with IBM, working in senior marketing and sales

positions, including CEO of IBM Australia/New Zealand.

He joined the Academy in 2013.

Mr Thodey is an experienced board chairman and director. In January 2013 he joined the Board of the GSM Association, the global body of carriers and related companies that supports the standardisation and deployment of mobile technology around the world. Former board memberships include co-chair of the Infrastructure and Investment Taskforce of the B20 leadership group, and Chairman of IBM ANZ, TelstraClear, Information Technology (IT) Skills Hub, Industry Groups and Basketball Australia.

Announcing the appointment former Industry and Science Minister Ian Macfarlane said Mr Thodey was one of Australia's most well-known and respected businessmen.

"He will bring a wealth of industry acumen to Australia's peak science agency as it plays an increasingly central role in maximising our economic opportunities and industry growth," Mr Macfarlane said.

"We know that capitalising on our nation's areas of competitive strength

and securing the jobs of the future in the fast-changing global economy will depend on lifting the rate of collaboration between industry and researchers.

"Mr Thodey is an innovative Australian businessman and an experienced board chairman and senior executive who offers expertise in management, corporate and government relations, information and communications technology, and sales and marketing.

"Mr Thodey's experience in building business networks will be valuable to CSIRO as it implements its new 2020 Strategy."

Mr Thodey said: "I feel privileged and honoured to be asked to contribute to the future of the CSIRO – an outstanding community of researchers and scientists.

"As the Minister has said, we, as a nation, have an important opportunity to collaborate across the research community and industry to improve Australia's global competitiveness. This is essential for the future of our country.

"Consistent with the new CSIRO vision, I hope that the CSIRO can be a catalyst for innovation across key focus industries and the wider community. We must make sure that Australia remains a global leader in the areas of science, research and industry innovation."

JOHN GOUGH WAS A BUSINESS GIANT

Melbourne businessman and textile engineer Mr John Gough OBE AO FTSE, a former Managing Director and Chair of Pacific Dunlop who served on the boards of BHP, ANZ, ICI Australia and Amcor, was an enormously influential figure in Australian business over a long period.

A Fellow since 1992, he was a stellar contributor to a wide array of organisations. He died in Melbourne in July, aged 86.

Educated at Melbourne Grammar, he studied textile engineering at Leeds University, graduating in 1950, before returning to Australia for a brief career in advertising before working in textiles and footwear during the 1950s and 1960s.

He joined iconic Australian company Dunlop in 1970. He worked his way through the Dunlop group in increasingly senior roles.

He became head of its footwear division, and pioneered international trade with China at the height of the Cultural Revolution.

He was appointed Managing Director in 1980, then Deputy Chairman in 1987 before serving as Chairman from 1990 until his retirement in 1997.

He was also involved in the German–Australian Chamber of Industry and Commerce, the Australia Israel Chamber of Commerce, the Australia-Japan Business Forum, the Ian Potter Foundation, Melbourne's Royal Botanic Gardens, the National Gallery of Victoria, the University of Melbourne Council, the Graduate School of Business – and many more organisations.

Extensive media tributes followed John Gough's death.

The *Australian Financial Review* described him as "easy to stereotype as a member of the Melbourne business establishment" and "moulded by a more genteel past" but acknowledged that his "remarkable business career testified to an agile, firm and at times ruthless business mind, with his eyes firmly on the future".

"He was ahead of his time in forging close business links with Asia, understood the implications of globalisation, knew his

way around the offices of investment banks in Manhattan and was a bold innovator in business education."

He served on an array of government committees, held numerous



John Gough

educational appointments and won many awards – Monash University's David Syme Business School International Businessman of the Year (1986), the Australian Institute of Management John Storey Medal (1988) and *Australian Business* magazine's Australian Businessman of the Year (1988).

His 1992 Fellowship Citation says he was "a pioneer of Australia's participation in the globalisation process of Australian manufacturers, where a combination of local and overseas processing was necessary to maintain competitiveness of the industry".

ATSE IN FOCUS

Mark Cassidy honoured: WA Scientist of the Year



Mark Cassidy

Professor Mark Cassidy FTSE has been named 2015 WA Scientist of the Year.

Professor Cassidy is an Australian Research Council Laureate Fellow, the Lloyd's Register Foundation Chair of Offshore Foundations and Director of the Centre for Offshore Foundations at The University of Western Australia. He is also the Deputy Director of the Australian Research Council Centre of Excellence for Geotechnical Science and Engineering.

He has been a key in designing offshore platform and pipeline infrastructure currently being constructed off the coast of WA.

Announcing the \$50,000 Award, WA Premier Colin Barnett said Professor Cassidy's work was contributing to WA's capabilities in the safe and economic construction of oil and gas platforms in the oceans.

"Professor Cassidy's research has identified solutions to unlock the vast reserves of stranded gas in our remote and deep oceans. It is the application of this science that will allow WA to harness opportunities and become a world leader in operating and maintaining this technology," Mr Barnett said.

As Director of COFS, Professor Cassidy, a former Prime Minister's Malcolm McIntosh Australian Physical Scientist of the Year, has

secured millions of dollars in research grants for devising novel foundation solutions for the installation of oil and gas infrastructure in complex and uncertain seabed conditions off Australia's coasts.

Professor Peter Klinken, Chief Scientist of Western Australia, was chair of the judging panel for the 2015 awards.

The Premier's Science Awards (formerly the WA Science Awards) were established in 2002 to recognise and celebrate the achievements of the WA science community.

Past winners of the WA Scientist of the Year title include Professor Mark Randolph FRS FREng FAA FTSE (2013), Professor Peter Quinn FTSE (2012), Professor Michael Tobar FAA FTSE (2010) and Professor Jorg Imberger AM FAA FTSE (2008).

ALAN FINKEL WINS IET'S MOUNTBATTEN MEDAL

Academy President Dr Alan Finkel AO FTSE has been chosen to receive the 2015 Mountbatten Medal from the Institution of Engineering and Technology in recognition of his "research in science and engineering, technical and academic leadership, entrepreneurship and philanthropy and dedication to science and engineering education".

The Mountbatten Medal, established in 1992, is awarded for a sustained, outstanding contribution to the promotion of electronics or information technology and their application. IET is the world's biggest multidisciplinary professional engineering institution.

Dr Alan Finkel is Chancellor of Monash University, co-founder and Chair of *Cosmos* magazine, Chair of the Australian Centre of

Excellence for All-Sky Astrophysics and the Executive Chair of Stile Education. He was awarded his PhD in electrical engineering from Monash University and worked as a postdoctoral research fellow



Alan Finkel

in neuroscience at the Australian National University.

In 1983 he founded Axon Instruments, a California-based company that made precision scientific instruments used at pharmaceutical companies and universities for the discovery of new medicines. Subsequent to Axon being acquired, since 2006 he has enjoyed a varied business career that includes property development and a period in electric vehicle charge network provision.

Dr Finkel is passionate about educating the next generation. He established the Australian Course in Advanced Neuroscience to provide advanced training to early-career scientists and he leads the ATSE secondary school science program STELR, which is currently running in nearly 500 secondary schools around Australia.

ALEC BROERS IN AUSTRALIA

Lord Alec Broers Kt FRS FREng FTSE, an Honorary Fellow since 2002, visited Melbourne in September in his role as Sir Louis Matheson Distinguished Visiting Professor at Monash University.

Lord Broers is a leading microelectronics engineer and university administrator and is regarded as one of the pioneers in the field of nanotechnology.

He spent more than 19 years working for IBM USA, as well as playing a significant role in the University of Cambridge's rise as a major economic force and centre of excellence for high technology.

He was Cambridge Vice-Chancellor (1996 to 2003), is a former President of the Royal Academy of Engineering and was made an IBM Fellow in 1979.

Lord Boers was made a Life Peer for his contributions to engineering and higher education in 2004 and continues to have a strong passion for, and insight into, the future of engineering and the role of universities.



Alec Broers

ATSE IN FOCUS



Craig Simmons

Craig Simmons named SA Scientist of the Year

Flinters University water scientist Professor Craig Simmons FTSE has been named 2015 South Australian Scientist of the Year.

Professor Simmons is recognised for his work on groundwater, a resource of critical importance to the Murray–Darling Basin system, water and food security, mining and the nuclear industry, and coal seam gas and fracking.

A strong advocate for groundwater research, he established the National Centre for Groundwater Research and Training, becoming the Inaugural Schultz Chair in Environment at Flinders University in the process. He became a Fellow in 2014.

SA Science Minister Gail Gago praised Professor Simmons, saying his outstanding personal contribution was helping to build a prosperous, sustainable Australia.

Professor Simmons' win coincides with another public honour – being named as Scientist in Residence at Adelaide newspaper *The Advertiser*, under a program devised by the Australian Science Media Centre to promote public knowledge of Australia's world-leading research.

Professor Simmons said groundwater depletion and pollution are huge international issues.

"Here in Australia, groundwater provides more than 30 per cent of total water consumption and generates national economic activity worth more than \$34 billion a year," he said.

"A myriad of pressing groundwater issues in Australia includes the implementation of the Murray–Darling Basin Plan, the impacts of unconventional gas and hydraulic fracturing and mining, impacts of climate change and role of groundwater in urban and rural water security.

"They all require rigorous groundwater science, management and policy."

Former SA Scientists of the Year include Professor Graeme Young AM FTSE (2013), Professor Karen Reynolds FTSE (2012) and Professor Tanya Monro FAA FTSE (2010).

MARTIN THOMAS WINS AGM MICHELL MEDAL

Mr Martin Thomas AM FTSE, a Fellow since 1991 and former Vice President of ATSE and chair of the ATSE Energy Forum, has won the 2015 AGM Michell Medal, awarded by the Mechanical College of Engineers Australia.

The Award, named for pioneering engineer and inventor Anthony George Maldon Michell, recognises outstanding achievement and eminence in the practice of mechanical engineering, and conspicuous service to the profession.

Mr Thomas qualified in mechanical sciences from

Cambridge University in 1957. After early years with British Petroleum in London he joined Merz and McLellan in the UK, migrating with his family to Perth in 1967 to join Merz Australia, managing a number of isolated power-generation projects for developing mining companies.

He has had a lifetime career in energy consulting, moving to Sydney in 1976 and specialising in industrial energy conservation before retiring as a Principal of Sinclair Knight Merz and being appointed founding MD of the Centre CRC for Renewable Energy in 1995.

Former roles include chairmanships of industry association Austenergy, the NSW Electricity Council and the 2000 Olympic Energy Panel; deputy chair of the energy utility Australian Inland Energy and directorships of the Tyree Group and other listed and unlisted energy technology companies. He currently serves as chairman of Dulhunty Poles Pty Ltd.

He was the Institution of Engineers Australia National President (1991–92) and chaired the Mechanical College Board from 1985–88. He was President of the Australian Institute of Energy (1999 to 2001). In 2006 he was a member of Prime Minister Howard's Uranium Mining, Processing and Nuclear Energy Review, known as UMPNER. In 2008 he won the Peter Nicol Russell Memorial Medal, Engineers Australia's highest award.

Previous AGM Michell Medal winners include: Professor Grant Steven FTSE (2014), Dr John Hart-Smith (2012), Dr Alan Baker FTSE (2011), Dr Francis Rose FTSE (2007), Professor Peter Joubert AM FTSE – deceased (2001), Professor Roger Tanner FAA FRS FTSE (1999), Mr Don Fry AO FTSE (1997), Dr Robert Brown AM FTSE (1995), Professor Bill Melbourne FTSE (1993), Professor Ray Stalker AO FAA FTSE –

deceased (1991), Professor Alan Roberts AM FTSE (1989), Dr John Allen AM FTSE (1988), Professor Sam Luxton FTSE – deceased (1986), Professor Peter Fink FTSE – deceased (1985), Professor John Crisp AM FTSE – deceased (1984), Dr Arthur Bishop – deceased (1982), Mr Lionel Stern – deceased (1981), Mr Charles Warman – deceased (1980), Professor Kenneth Hunt – deceased (1979) and Dr M W Woods – deceased (1978).



Martin Thomas

ATSE IN FOCUS

EA's Sargent Medal to Alex Zelinsky

Chief Defence Scientist, Dr Alex Zelinsky FTSE, has been awarded the 2015 MA Sargent Medal from Engineers Australia. Dr Zelinsky received the award for his significant contributions to engineering, including technical innovation and leadership.

Secretary of Defence Mr Dennis Richardson said Dr Zelinsky was a worthy recipient of the engineering award. "His scientific leadership is an asset to Defence," Mr Richardson said.

Dr Zelinsky leads the Defence Science and Technology Group and has held other senior positions at the Australian National University and CSIRO.

His achievements include pioneering both the scientific development and engineering application of planning methods in robotics, specifically applied to autonomous robot navigation. He is also regarded as a world leader in the field of intelligent vehicles.

The World Economic Forum named Dr Zelinsky a Technology Pioneer in 2003, 2004 and 2005. He has been included in Engineers Australia's list of the 100 most influential engineers since 2009.

Dr Zelinsky said he was deeply moved by the recognition.

"My career has given me the opportunity to work with many brilliant engineers over the years and without their support I would not have received this award.

"I am particularly moved to receive the MA Sargent Medal. Dr Sargent is an eminent Australian engineer whom I admire and I have had the pleasure of working with him."

The MA Sargent Medal – named for Academy Fellow Dr Michael Sargent AM FTSE – is awarded annually by the Colleges of Electrical Engineering and Information, Telecommunications and Electronic Engineering. Dr Sargent is an outstanding Australian electrical engineer and past President of the Institution of Engineers, Australia.

Previous winners include Fellows Dr John O'Sullivan FAA FTSE, Dr Trevor Bird FTSE, Dr David Skellern FTSE, Dr Barry Inglis FTSE, Professor Brian Anderson AO FRS FTSE, Professor Mike Miller AO FTSE, Mrs Else Shepherd AM FTSE, Professor Rod Tucker



Alex Zelinsky

OAM FAA FTSE, Professor Martin Green AM FRS FTSE, Dr John Edwards FTSE, Dr John Ness FTSE, Professor Graham Goodwin FRS FAA FTSE and former Chief Defence Scientist, Professor Henry d'Assumpcao AO FTSE.

NEW HONOURS FOR MAX LU

The University of Queensland's Provost and Senior Vice-President, Professor Max Lu FAA FTSE, has won The Chemical Society of Japan's annual lecture on colloid and interfaces – delivered in Kagoshima in September.

Professor Lu said he was pleasantly surprised and honoured by this Colloid and Surface Chemistry Lectureship Award.

UQ President and Vice-Chancellor Professor Peter Høj FTSE said the honour recognised Professor Lu's status as a globally respected researcher in the fields of materials chemistry and nanotechnology.

"His seminal discoveries have the potential to provide massive benefits to future generations in clean energy, the environment and health care," Professor Høj said. "I congratulate Max on the award. It adds further weight to his reputation as a researcher who has made contributions to create change on an international scale."

Professor Lu is Thomson Reuters highly cited scientist in both chemistry and materials science categories (with more than 30,000 citations and h-index of 89). His numerous national and international awards include the China International Science and Technology Award, Orica Award, RK Murphy Medal, Le Fevre Prize, ExxonMobil Award, Chemeca Medal, Top 100 Most Influential Engineers in Australia and Queensland Great.

Professor Lu grew up in Shandong Province

in eastern China and studied engineering at Northeastern University. He came to Australia in 1987 to study for his PhD at UQ and has been a full-time academic at the university since 1994.

US ACCLAIM FOR LIANG-SHIH FAN

The American Institute of Chemical Engineers (AIChE) has announced its Institute Lecturer for 2015 has been awarded to Professor Liang-Shih Fan FTSE, Distinguished University Professor and the CJ Easton Professor in the Department of Chemical and Biomolecular Engineering at Ohio State University.

Professor Fan, a Foreign Fellow since 2013, will present the 67th Institute Lecture on 11 November at AIChE's Annual Meeting in Salt Lake City, Utah.

The lectureship is awarded to a distinguished AIChE member who has made significant contributions to the chemical engineering sciences in his or her field of specialisation.

Professor Fan will discuss his next-generation invention of clean, chemical looping, energy conversion processes for CO₂ emission control and chemicals production, and his invention of electrical capacitance volume tomography (ECVT) technology used worldwide for multiphase flow imaging.

In his lecture, 'Metal Oxide Reaction Engineering and Particle Technology Science: A Gateway to Novel Energy Conversion Systems', Professor Fan will describe the general properties of metal oxide materials for emerging technology applications including novel chemical looping platforms that employ metal oxide composite particles as oxygen carriers to produce hydrogen, syngas, chemicals, and liquid fuels from carbonaceous feedstocks such as coal.

Professor Fan, who serves as director of Ohio State's Clean Energy Research Laboratory, is an international authority in the fields of particle science and technology and fossil energy conversion systems. He is a member of the US National Academy of Engineering, Chinese Academy of Engineering and Mexican Academy of Sciences.



Liang-shih Fan

ATSE IN FOCUS

Peter Joubert: pilot, engineer and sailor

Emeritus Professor Peter Joubert AM FTSE was widely known in Melbourne as an engineer, yacht designer and sailor, road safety campaigner, Professor of Mechanical Engineering at the University of Melbourne – and as a World War II pilot.

A Fellow since 1979, he grew up in Sydney – where he developed a love of sailing and the sea – and died Melbourne in July, aged 90. He attended his last Victorian Division meeting in October 2014.

He was educated at Sydney Boys High School and undertook an apprenticeship in mechanical engineering before joining the RAAF in 1943. He trained in Tiger Moths and gained a lifelong interest in transport safety and the value of seatbelts after being suspended upside down following a crash landing.

He flew with 76 Squadron in New Guinea on an 11-month tour based at island airfields to the north of New Guinea mainland, flying ship patrols and bombing and strafing raids.

For the latter part of the war he was a ferry pilot based at Laverton before joining the RAAF reserves – surviving a crash landing in a Lincoln bomber in 1948.

In later life he recorded his experiences in two booklets of flying tales, describing nonchalantly the extraordinary experiences and adventures through heat, rain, mud, malaria and accidents, as well the dangerous encounters with the enemy. In Peter's words: "people were shot down, some recovered, some died and I was lucky".

Participation in the Commonwealth Reconstruction Training Scheme followed. He graduated with a B.Eng. from the University of Sydney. He was appointed to the University of Melbourne in 1953, the commencement of a long and distinguished academic career.

Professor Joubert's innovations and designs spanned a range of interests – submarines, yachts, road safety and turbulence. Working with his postgraduate students, he made substantial research contributions into the mechanisms of surface

flow in boundary layers and turbulent flow.

Passionate about submarine design he advised the Australian Government on

flow-related issues with the Collins Class submarine. He was working with the Australian Defence Department nearly until his death. His innovations are currently being used as a benchmark for scientific studies on flows around submarines in many countries around the world.

He was a designer of ocean racing and cruising yachts including *Zeus II*, which won

the 1981 Sydney-to-Hobart race. He named his yacht designs after Australian birds, including the Currawong 31, Brolga 33 and Magpie 34, and more than 100 yachts were built to his designs. He competed in 27 Sydney-to-Hobart races, mostly skippering yachts of his own design. He sailed his beloved *Kingurra*, a 43-foot yacht of his design, in 14 Sydney-to-Hobarts.

In 1993 he was awarded the CYCA Commodore's Medal for outstanding seamanship. He rescued eight crew of the yacht

Adjuster, which foundered at night in a strong gale. Peter survived the treacherous 1998 Sydney-to-Hobart, where a crewmember was lost overboard (and later rescued). *Kingurra* capsized but was able to right itself.

He was widely sought as a consultant and expert court witness and was known for his long interest and expertise in road safety. He was an early promoter of legislation for the compulsory wearing of vehicle seatbelts based on his wartime experience.

High intelligence was combined with strong opinions and determination and Professor Joubert could be demanding of people. As a friend he was loyal and compassionate. His demand for intellectual rigour and critical thinking has in part contributed to the success of many people he worked with.

He received the Order of Australia Medal (OAM) in 1996 for his contribution to road and yacht safety and in 2009 was made a Member of the Order of Australia (AM) for service to engineering through research in the field of fluid dynamics, particularly in relation to submarine design and education.

Contributed by Dr Glen Kile AM FTSE



Peter Joubert



ATSE SA TEACHER AWARD TO DR SAM MOYLE

ATSE SA Division Secretary Dr John Radcliffe presents the Academy's 2015 SA Teacher Award to Sam Moyle, of Adelaide's Brighton Secondary School, for her "innovative contribution to teaching and learning" in science, robotics and 3D design. Dr Moyle is a member of the SA Chief Scientist's STEM Advisory Group and has received numerous awards including SASTA Outstanding Teacher (2013), SA Early Career STEM Educator (2014) and Apple Distinguished Educator (2015). Her Award citation notes that Dr Moyle "has demonstrated exceptional creativity and leadership that is encouraging many students who would otherwise have moved away from STEM subjects to stay on and excel". Dr Moyle received a plaque and a \$2000 cheque for the school.

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dream large



To know that I can impact on people's lives is such a motivating and inspiring feeling

Hosam, UQ PhD student

Under the mentorship of renowned infectious diseases expert Professor David Paterson, Hosam is creating a diagnostic tool to rapidly identify antibiotic-resistant superbugs, to help save lives. The tool has the potential to allow patients to be treated quickly and minimise opportunities for the deadly superbugs to spread. By learning to see the world differently, Hosam is creating change. See Hosam's story at uq.edu.au/createchange



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