



FOCUS

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FOOD SECURITY

**TIME TO FOCUS ON OPTIMISING OUR
AGRICULTURE AND FOOD SUPPLY**

Contributors discuss the challenges and opportunities
for Australia in food supply for itself and the world.



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

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The key objectives of API are to achieve the following:

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

Further Information

Contact - Mike Griffin (Chief Executive)



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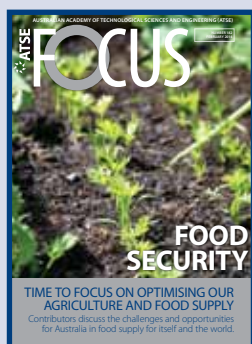
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ATSE *Focus* is produced to stimulate discussion and public policy initiatives on key topics of interest to the Academy and the nation. Many articles are contributed by ATSE Fellows with expertise in these areas. Opinion articles will be considered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

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International biosecurity – the Svalbard (Norway) Arctic ‘doomsday’ seed vault where Tony Gregson deposited Australian crop seeds for the first time three years ago.

Biosecurity: securing food production from serious plant pests

The number of pests classified as high-priority threats to Australia’s plant industries now stands at more than 300.



By Tony Gregson

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Australia is a leading agricultural producer and net exporter of food, contributing well above its weight to global food security each year.

In 2011-12, the gross value of Australian crops was more than \$27 billion, the majority of which was food. Livestock production also relies on plants in the form of pasture and fodder, bringing the total value of agricultural production that year to an estimated \$41 billion.

One of the reasons for Australia’s thriving agricultural system is the relative freedom from many of the pests and diseases that hamper production elsewhere in the world. We have a wide range of climates, allowing us to produce tropical fruits and sugarcane in the north to cherries in the south, with a large number of horticulture and grain crops in between.

These wide-ranging production environments mean that there are many exotic pests that could threaten these production systems. The number of pests classified as high-priority threats to Australia’s plant industries now stands at more than 300. The threat that

each of these pests poses to our plant industries needs to be recognised and managed if Australia is to maintain its ability to produce food for the world.

Plant pests can be devastating in intensive agriculture systems, as a few examples clearly illustrate. Rice blast is a notable case due to its devastating effects on production. A recent article published in *Molecular Plant Pathology* identified rice blast (*Magnaporthe oryzae*) as the number one fungal pathogen of concern for global food security. Rice blast is the most destructive disease of rice in a world where rice is the staple food source for half of the population.

Currently, Australia does not have any rice blast in the primary production areas of the country but there are strains present elsewhere in Australia, including severe strains in the north. Plans to increase production by growing rice in the Ord River Irrigation Area will quickly come to a halt without significant efforts to manage this serious biosecurity threat.

As well as pests that reduce yield, some plant pests wreak havoc after crops

have been harvested but before they make it to our tables. Food wastage is a major threat to food security, with waste estimated to be as high as 50 per cent of all food produced; pests make a large contribution to that enormous statistic, by spoiling food before it can be eaten.

Khapra beetle (*Trogoderma granarium*) is a common culprit in wastage of grain stored for future consumption and can cause losses of up to 75 per cent. It is not currently found in Australia, so our grain exports – worth up to \$9 billion each year – continue to make a substantial contribution to global food security. Nevertheless, the beetle is high on the list of pests that Australia does not want.

In addition to it being necessary to control pests to produce food, and then safely transport it to markets, the absence of particular pests in Australia is often a prerequisite for exporting to countries overseas. The presence, or even just the suspected presence, of significant pests can close access to a market overnight.

In grains, the primary example is Karnal bunt (*Tilletia indica*) a fungal

infection of wheat, durum and triticale. Many countries restrict access to grain that has been shipped from anywhere that could be contaminated with the fungus. Australia is continually checking for this pest in grain storages across the five grain-producing states to provide the evidence of the absence of Karnal bunt required to maintain our grain export markets. There are many other examples of pests that would close markets to Australian produce, or at least impose new trading conditions, if we let our guard down.

For more information on PHA visit www.planthealthaustralia.com.au.
Producer biosecurity information is available at www.farmbiosecurity.com.au.

In addition to efforts to exclude exotic pests, there are some pests that are established in restricted areas of Australia and are only contained there by ongoing domestic quarantine activities. Phylloxera (*Daktulosphaira vitifoliae*), an insect pest of grapevines, and the Queensland and Mediterranean fruit flies (*Bactrocera tryoni* and *Ceratitis capitata*) are examples of regional pest problems kept in restricted areas of the country by movement controls. These efforts allow other pest-free areas to continue to export their produce both domestically and internationally. Currently, Japan accepts the import of cherries from Tasmania only, since the island state is free from fruit fly.

Pesticides are often a solution to plant pests in intensive agriculture, sometimes used before, during or after production to ensure a good yield and safe passage to homes around the world. However, the need to use pesticides can add considerable expense to production, sometimes threatening industry viability and often placing additional pressure on the affordability of food. There is also a trend to reduce agriculture's reliance on chemicals, including pesticides, for multiple reasons, including concerns for human health.

Recently in Australia a review of the pesticides dimethoate and fenthion, commonly used to control fruit flies, resulted in restrictions in use patterns for these chemicals, posing considerable challenges to horticultural producers. In addition, resistance to pesticides is developing, further reducing management options available to producers. Urgent work is needed to explore new and innovative options and strategies for future pest control.

Australia has a world-class border control system to protect us from exotic pests, but there is always the chance that one will get through the border or arrive via natural means and establish in our farms and orchards. Steadily increasing trade volumes and passenger movements, coupled with the natural movement of pests, changing habitats due to climate change and evolving forms of endemic pests, pose continual risks to our productivity and access to markets.

We need an effective onshore

biosecurity system to respond to these pest detections quickly and effectively to provide the best chance of eradicating them before it's too late. Since 2005, Australia has had an innovative and effective plant pest incursion response system to supplement border biosecurity.

The Emergency Plant Pest Response Deed (EPPRD) is a legally binding partnership agreement between peak plant industry bodies and all Australian governments and Plant Health Australia (PHA). It sets out what is to happen when a suspected emergency plant pest is reported, thereby facilitating a swift, transparent and certain response.

The EPPRD cements the government–industry biosecurity partnership, providing Australia with a unique and very powerful post-border system. PHA is a not-for-profit company funded equally by three groups – one-third by the Australian Government, one-third by all state and territory governments and one-third by peak plant industry bodies. This membership base is powerful because PHA can address priority plant biosecurity issues with impartiality and the close association between governments and industry means that all parties can support targeted activities and participate in national policy development.

In addition to being a valuable framework for responses to incursions of Emergency Plant Pests, the EPPRD also strengthens the biosecurity system by obligating all signatories to play their part in reducing the likelihood of an incursion and developing preparedness plans to reduce any impact on production. On behalf of members, PHA runs a farm biosecurity program in conjunction

with its sister organisation Animal Health Australia, to raise awareness of practical on-farm biosecurity measures for plant and animal production.

PHA is also able to provide national coordination of biosecurity training, capacity building, data gathering and information dissemination, as well as work with individual industries to assess and mitigate their main threats to production. In 2010, PHA released the National Plant Biosecurity Strategy, providing Australia's first national plan for the plant biosecurity system to 2020.

Plant biosecurity underpins Australia's ability to produce food, yet it is vastly undervalued and underfunded. This was acknowledged in 2008, in a national review of biosecurity in Australia (the Beale Review), yet since then there have been reductions in biosecurity staff almost universally across all governments due to budget reductions. As well, industries are also battling to maintain their levels of investment in biosecurity, let alone make up the shortfalls.

It's hard to overestimate the importance of a strong biosecurity system for our island nation.

Our incredibly versatile, innovative and productive agricultural system has the potential to grow and play an important role in global food security. Australia is well placed to respond to the growing food demands of Asian countries, but we are not going to be able to do this if we relax our guard against exotic plant pests.

It will take continued commitment from all stakeholders to maintain and enhance our plant biosecurity system. The resulting benefits for growers, industries, rural communities and our economy are potentially large and wide-ranging.

DR TONY GREGSON AM FTSE is a grain grower from the Wimmera region of Victoria. He has degrees in science (PhD and DSc) from the University of Melbourne and is an Adjunct Professor at the University of Ballarat. He is Chairman of Plant Health Australia, the Victorian Committee of the Crawford Fund and the University of Melbourne Botany Foundation. He is a former ICI Research Fellow at St Edmund Hall, Oxford, former Chairman of Bioversity International in Rome and two CRCs, former inaugural member of the CSIRO and GRDC boards and a former member of the CIMMYT, ANSTO and Rural Finance Corporation of Victoria boards.

Are soil and fertiliser resources sufficient for our food security?

By 2025 it is likely that new paradigms of food production will need to be in place to augment land-based production systems.



By Roger Swift
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Soils are the basis for production of the vast majority of food, natural fibres and wood – a situation that is certain to continue for very many years to come.

In addition to existing products, add in new crops for biofuel production plus the expanding demand for land-hungry animal protein to appreciate the growing production pressures falling on a fixed area of land.

Clearly, we will need sufficient areas of high-quality, fertile soils to meet the ever-increasing demand for food and other soil-based products.

Although much of our food is grown and supplied locally, a wide range of agricultural commodities are traded worldwide and we need to know the amount, quality and global location of soils if we are to manage future soil-based production issues.

Soil resources

Most of the world's soils have use limitations resulting from their properties (for example, stoniness, shallowness, salinity or acidity) or environment (for example, excessively cold, dry, wet or mountainous) or many combinations of these. Only 10 per cent of the Earth's soils with minimal limitations are suitable for intensive crop production.

Substantial areas of the remaining soils can still be reasonably productive if their limitations can be wholly or partly overcome by economically feasible solutions (for example, drainage, irrigation, liming, choice of crop, and so on). This increases the portion of the landmass available for plant and (particularly) animal production to around 40 per cent (see Table 1) but the amount of flexible, high-quality cropping land is the main concern.

Are there unexploited reserves of



Basic agriculture – hand-fertilising rice.

arable soil in underdeveloped areas? There is considerable scope to increase cropped areas in sub-Saharan Africa, Latin America and parts of East Asia. There is little scope in the more developed areas of the world.

Efforts to increase areas of cropping soil need to be carefully planned and skilfully managed to avoid some of the past catastrophes. Bringing virgin land into production involves clearing native vegetation, mechanically cultivating the soil, protecting, harvesting and processing the new, often exotic, crop. The combined effect causes major biological, physical and environmental changes within the system – often causing deterioration in soils' physical condition, resulting in man-

induced soil degradation and erosion.

Soil degradation is now a major threat, with large and increasing areas of arable and pasture land affected to some extent by soil erosion. It is estimated that some five million hectares of productive land are lost each year due to degradation resulting from deforestation, overgrazing and general mismanagement.

Improved soil management and husbandry practices help to minimise these losses, but as the pressure on productive land increases the amount lost each year as a result of land degradation, contamination and ever-increasing urban sprawl is likely to increase, placing even greater pressure on the remaining productive land.

Table 1 Global land use*

Land use	Approximate area (%)
Arable	11
Permanent crops	4
Pastures	24
Forests/woodlands	31
Urban	1.5
Other	29
* Total land area: approximately 150 x 106 km ²	

PHOTO: IIRI

Fertiliser resources

Aside from carbon, hydrogen and oxygen, all of the other essential plant nutrients are provided by soil.

In natural systems, these nutrients cycle through the soil/plant system and are reused. In agricultural systems significant amounts of nutrients are removed each year in produce and yields decline over time unless the nutrients are replaced using fertiliser.

The capacity of soils to feed the world's current population is heavily dependent on fertiliser use. Although improved crop varieties and management practices have been important in increasing productivity, it is principally through the use of fertilisers that soil productivity per hectare has increased sufficiently to keep pace with the needs of the growing population over the past 70-plus years, despite the related decline in the area of land used on a per capita basis.

Can fertiliser supplies can be maintained and increased to meet future needs? The answer depends on the availability and supply of the three main nutrients in fertilisers – nitrogen, phosphorus and potassium.

Fertiliser **nitrogen** is derived from the atmosphere by chemical conversion initially into ammonia, and the cost of production is principally related to the cost and availability of energy for the process. As the fertiliser nitrogen eventually returns to the atmosphere, as a result of biological denitrification processes in soils and sediments, the ongoing availability of nitrogen for fertiliser manufacture is not a concern.

Potassium is produced by mining or brine extraction from large deposits in a number of countries. These together with other known commercial reserves (totalling 17 billion tonnes K_2O) will provide sufficient potassium for the next 500-plus years and the total, much lower quality, resource base of potassium (about 200×10^9 tonnes K) would last for several thousands of years but it would become increasingly expensive to recover as resources were depleted.

Phosphorus is the element of greatest current concern and has been the cause of some debate in recent times in terms of the timing and meaning of 'peak phosphate'. Estimates of how long the deposits of rock phosphate will last

currently range from 60 to 400 years.

The difficulty with making these predictions is caused by uncertainty in the estimates of rock phosphate. Lower estimates are based on a value for rock phosphate reserves of 16×10^9 tonnes which was recently revised by the US Geological survey (USGS) to 60×10^9 tonnes, based largely on a reassessment of the Moroccan-controlled deposits which now account for 85 per cent of the higher-quality reserves.

The amount of phosphate in much lower grade deposits is much greater but the costs of extraction and concentration would be very high.

In order to extend the lifetime of current phosphate reserves we need to devise new fertilisers, carefully tailor rates of application, find ways to use reserves held in soil, increase the efficiency of uptake by plants and recover phosphorus from waste streams for recycling.

International outlook

Notwithstanding these soil and fertiliser issues, it is likely that the current production systems – with new developments and improvements – will be able to carry us through to around 2025, when the amount of arable land per capita will fall to about 0.1 ha per person due to population increase and soil erosion.

At this stage it is likely that new paradigms of food production will need to be in place to augment land-based production systems.

Australian outlook

Unlike other continents, soil-rejuvenating process such as tectonic uplift, volcanic activity and glaciation have been very low or absent for a long time in Australia. As a result many of our soils are deeply weathered with high oxide contents, very low inherent nutrient fertility and a range of other significant chemical and physical limitations.

Despite this general situation, there are significant areas of soil located in regions with adequate rainfall which, with input of fertiliser (particularly phosphorus), are capable of reasonable levels of crop production.

The area of this regularly or intermittently cultivated and cropped land is about 48 million ha and in any given year about 17 million ha carry crops and there are 30 million ha of sown pastures.

Much of the sown pasture area is used to fix nitrogen biologically for animal production and/or subsequent cropping.

The area of 'arable' land comprises only six per cent of Australia's total land surface of 766 million ha, well below the average figure for other continents.

An almost ten-fold larger area of 420 million ha is used for extensive grazing with low per-hectare production. It is through the combination of these two areas that agriculture is said to affect 60 per cent of Australian land.

It is well known that Australia produces sufficient food for about 80 million people, more than three times its own population. While these exports make a valuable contribution to the world food supply it hardly makes us the 'food bowl of Asia' with its population of 4300 million!

A more important question is can we produce more from Australian soils as demand continues to grow? The answer is 'yes' but would require making radical decisions about water use and location.

For example, irrigated land produces 2 to 2.5 times as much per hectare as rainfed agriculture, but this would require greater allocations of water for existing agriculture land. There are also soils in northern Australia that should be brought into production using rainfed or irrigated systems as appropriate. Again, this would require bold decisions but, given the time taken to develop new resources and the scale of the emerging problem, it would be wise to address them sooner rather than too late.

Whether or not we have the willpower to make these decisions depends on how we view our place in the world and the gravity of the emerging situation.

But if we do not make these decisions ourselves there are billions of people to our north who will be keen to assist us.

PROFESSOR ROGER SWIFT FTSE is a soil chemist who is internationally recognised for his contributions to soil science. He has held Chairs of Soil Science in New Zealand, the UK and Australia and served as Executive Dean of the University of Queensland, Vice-Principal of Lincoln University and Chief of CSIRO Division of Soils. His research interests include soil organic matter, carbon sequestration, nutrient chemistry, and the use of stable and radioisotopes. He has around 200 original publications with more than 6500 citations. He is Fellow of the Royal Society of Chemistry and has served as President of the International Union of Soil Sciences.

Processing innovation has a key role in food security

It is clear that many factors affect food security but it is underpinned by sustainable food systems.



By Michael Eyles and Mary Ann Augustin
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Innovation in agriculture has a central, unquestioned and well-understood role in food security but achieving food security requires recognition of the complex interplay between agricultural food production, preservation, processing, packaging, distribution and marketing through to the consumption of food.

Therefore in addressing food security challenges we must take a holistic approach to the food chain and ensure that we do not underestimate the role of innovation in food processing.

Without food processing, which includes long-established technologies such as drying, freezing, heat and fermentation, and emerging technologies like high-pressure processing, a significant amount of the food produced on-farm simply cannot reach the consumer.

However, the implications of processing for food security go well beyond this basic reality.

The food processing industry has grown dramatically in technological sophistication, against a backdrop of rapid urbanisation of populations and internationalisation of industries. This technological development has enabled remarkable growth in complexity in the marketplace, while continuing to deliver basic requirements such as good nutrition, safety and value for money.

A few minutes in a large supermarket makes it very clear that the industry's diverse product range is successfully tailored to the specific needs and desires of many different groups in the population, saves large amounts of time in busy lifestyles, contributes to various dimensions of health and well-being and, in some cases, provides fun and entertainment.

With attention turning increasingly to fundamental issues of food security and sustainable production,

the processing industry has a new set of challenges to address.

Innovation in food processing intersects with the multidimensional issue of food security in many ways. The World Food Summit of 1996 defined global food security as a condition where "all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life". Hence, food security is a complex challenge and there are many perspectives in the interconnected web of food system activities that need to be addressed.

Ensuring food security outcomes for society cannot be separated from considerations of the effects of activities across the whole food supply chain on climate, the environment (for example, greenhouse gas emissions, water footprints, pollution) and biodiversity, and their consequent effects on the health and well-being of the population. There is

also increasing societal pressure to ensure that food is produced in an ethical way.

It is clear that many factors affect food security but it is underpinned by sustainable food systems.

Some consider that sustainability will be driven primarily by changes on-farm, but it is equally important that appropriate processing technologies are applied to ensure that primary produce can be turned into consistent products that are safe, nutritious, have consumer appeal and have a good shelf life for distribution.

Altered on-farm practices used to increase yields (for example, through animal genetics, feed, land-use) are often accompanied by changes in composition and the structure of the agri-food raw material, which in turn can have an influence on its ability to be processed into consistent food ingredients and products that consumers want.

Understanding the composition and structure of the raw materials and the



CSIRO pilot-scale food process development.

Microencapsulation and other sophisticated technologies are being used to protect and enable delivery into foods of sensitive and unstable nutritional ingredients such as omega-3 oils and probiotics.

amenability of the altered raw materials to be processed into acceptable consumer products requires a fundamental understanding of the interactions between the raw material and food processing operations. This understanding allows us to get the most out of the raw material that is produced.

As an example, the Australian dairy industry appreciates the consequences of on-farm practices on milk quality and its impact on processing of milk into ingredients and consumer products. The industry has adopted a more integrated approach across its whole supply chain to improve its sustainability and competitiveness.

Minimising waste and thereby gaining maximum benefit from the food that is produced is also a key focus. All activities across the food system contribute to waste production, which is substantial. An expert working group of the Prime Minister's Science, Engineering and Innovation Council concluded that

estimated losses and wastage across the food value chain may be in the order of 50 per cent at the global level.

Processing innovation has an important role to play in reducing wastage, with the nature of the technological solutions varying considerably depending on local circumstances.

An essential part of the sustainable chain is to use the whole of the product – to recover waste, to add value to by-products, to recycle water. The development of technologies, processes and products to reduce waste and maximise value addition through the supply chain has recently been agreed as an innovation priority by the Australian food industry and associated research organisations.

The approaches that are being used include the growing adoption of separation technologies to extract components and add value to waste streams. For example, proteins and other valuable components

are being extracted from whey, a by-product of cheese-making, and flavours are being extracted from citrus peel.

A study conducted under the auspices of the UK Global Food Security Programme that focused on post-farmgate food system activities suggested that nine elements underpinned food security. These can be grouped in the three categories of utilisation (nutritional value, social value, food safety), access (affordability, allocation, preference) and availability (production, distribution and exchange). Consumer preferences extend to fair trade, ethical production and food choice governed by religious practices. Processing innovation has a significant impact on most of these nine elements.

If we look more closely at just one of these dimensions, utilisation, we can see the essential role of food processing innovation. Processing makes a fundamental contribution to the maintenance of food safety, such as through the application of preservation technologies to ensure sufficient safe life of a product, including the retention of nutrients.

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CONTENT MATTERS

Processing innovation is also contributing to improved nutrition through the development of foods with reduced levels of components that are the focus of consumer concerns about health (for example, reduced-salt or low-sugar foods) or with increased levels of desirable nutritional ingredients (for example, fibre) whilst maintaining safety, taste, texture and other aspects of consumer appeal.

In the latter case, microencapsulation and other sophisticated technologies are being used to protect and enable delivery into foods of sensitive and unstable nutritional ingredients (for example, omega-3 oils, probiotics).

The potential contributions of food technology are diverse. In addition to the examples above, there are opportunities for improved access and availability through the application of new and emerging technologies (for example, high-pressure processing) as alternatives to conventional processes (for example, heat sterilisation) for preservation, the introduction of intelligent decision-making tools in food manufacturing plants based

on real-time analysis and feedback loops to markets and consumers, and so on.

It is acknowledged that a multifaceted approach to developing sustainable food systems is required to drive desirable food security outcomes for the health and well-being of society.

However, there is a growing understanding that apart from meeting the challenges of increasing agricultural production, the challenge of feeding the world requires us to innovate using food processing technologies to transform agri-food raw materials into foods for all people, making 'more from less' and developing strategies to waste less in an environmentally friendly manner in a resource constrained world.

Further reading

- Augustin MA, Udabage P, Juliano P and Clarke PT (2013) Towards a more sustainable dairy industry: Integration across the farm-factory interface and the dairy factory of the future. *International Dairy Journal*, 31, 2-11
- Ingram SI *et al.* (2013) Priority research questions for the UK food system. *Food Sec.* 5, 617-636.

DR MICHAEL EYLES FTSE performed and led research and development related to the food industry in a variety of roles for over three decades, with a particular focus on food safety and quality. His past roles have included Chief of Division and Group Executive in CSIRO and President of the Australian Institute of Food Science and Technology. He is presently engaged with CSIRO and several other science-based organisations in activities related to strategy and change management.

DR MARY ANN AUGUSTIN FTSE is an internationally renowned food scientist in the areas of dairy ingredient development and microencapsulation systems. Her specialist expertise is in the areas of dairy ingredient science and technology, microencapsulation of bioactive ingredients, and sustainable and emerging food processing technologies. Dr Augustin has a long history of engaging with industry partners. She studied at Monash University and from 1979-88 held university appointments in Malaysia and the UK. She joined CSIRO in 1988 and is currently Leader of the Food Science Research Program at CSIRO Animal, Food and Health Sciences. She was also a Professorial Fellow at Monash in the mid-2000s.

ATSE HOLDS FOOD FUTURE SEMINAR

The Academy's NSW Division will hold a one-day food issues seminar on 1 May 2014 at CSIRO's auditorium at North Ryde, Sydney, in association with CSIRO and the Australian Institute of Food Science and Technology (AIFST).

'Innovating for our Food Future: Mining boom to Dining Boom?' will be opened by Professor Mary O'Kane FTSE, NSW Chief Scientist and Engineer, and feature a range of authoritative national speakers.

THE MORNING SESSION chaired by Dr John Keniry AM FTSE, agricultural producer and company director, will focus on the current food sector and future opportunities and needs for the food industry.

Speakers will include:

- **Mr Terry O'Brien**, Chief Executive, Simplot Australia, and Chairman, Australian Food and Grocery Council;
- **Mr Gary Dawson**, Chief Executive, Australian Food and Grocery Council;
- **Mr David Thomason**, Director, Seafood CRC, and Director, Fisheries R&D Corporation (previously General Manager Marketing, Meat and Livestock Australia);

- **Dr Martin Cole**, Chief, CSIRO Division of Animal, Food and Health Sciences; and
- **Mr Geoff Ball**, consultant.

THE AFTERNOON SESSION will focus on the role of innovation in securing the future of the food industry and strategies for science, technology and engineering. It will be chaired by Dr Jim Peacock AC FRS FAA FTSE, CSIRO researcher and former Australian Chief Scientist.

Speakers will include:

- **Dr Andre Teixeira**, Chief R&D and Quality Officer, Goodman Fielder Ltd;
- **Mr Peter Schutz**, Chairman, Food Innovation Australia;
- **Professor Mike Gidley**, Professor of Food Science and Technology, University of Queensland, and Director, Centre for Nutrition and Food Science; and
- **Associate Professor Jayashree Arcot** and **Dr Alice Lee**, ARC Training Centre for Advanced Technologies in Food Manufacture, University of NSW.

The seminar fee is \$150 (\$125 for Fellows) and registration is essential, at the ATSE website www.atse.org.au

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

Statistics critical in securing our food supply

Statistical science has been evolving by becoming increasingly entwined in all aspects of the information and decision-making value chain.



By Kaye Basford and Bronwyn Harch

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“World food security ... is at its lowest in half a century,” wrote Julian Cribb FTSE, a well-known consultant in science communication and founding editor of www.sciencealert.com.au in the lead article in the 2008 ATSE *Focus* magazine issue entitled “Food for the world: the nation’s challenge”.

Food security continues to be a key national and international concern and it is pleasing to see this issue of *Focus* again exploring aspects of the topic with the aim of continuing to raise awareness of issues and influencing relevant policy decisions.

Statistics (or statistical science, more broadly) has been critical to the information and decision-making value chain needed to optimise agriculture and the food supply chain. The key steps are most often addressed by multidisciplinary research groups including statisticians in collaboration with life and physical scientists, agri-industry personnel and other relevant stakeholders.

Contributions from statistical science to food security include:

■ Designing for data generation and capture

Statistical science has contributed vital innovation into experimental design for agricultural experiments and sampling designs in landscapes involving agriculture, for example, spatio-temporal, lattice, incomplete block and partially replicated designs. For plant breeding, appropriately designed multi-environment trials across locations, years and management systems generate the most useful data sets for plant improvement. Sensing technologies, ranging from nano and micro to macro and remote, are increasingly incorporated as part of data-capture networks in agricultural experimentation and surveying

enterprises as a farming system. The spatio-temporal analysis of real-time sensor data and other observational data has enabled endeavours in precision agriculture to deliver productivity gains.

■ Data generation, capture and storage

Statistical science contributes to on-board analytics (for example, outlier detection), real-time adaptive-based sensing in space and time, and the analytics needed to optimise the communication of signals (for example, compressive sensing) and data storage. Increasingly, statisticians are partnering with computer scientists and engineers to ensure design, analytics, visualisation and the experiences we have with data are optimised.

■ Access to and transmission of data

Storage of information requires privacy and confidentiality to be incorporated into the design and analysis of information architectures. While agricultural and food supply chain data have often provided ‘big data’ in the past (for example, germplasm collections, plant variety trials, microarray experiments), the interaction of data volume with the increasing velocity, variety, volatility, validity and veracity of data is unparalleled.

■ Integration and modelling of data

Data from various experiments and/or landscape surveys under the same management system are often integrated before analysis – for example, combining different data sets in the one field to eliminate spatial trend. Statistical analyses that combine data from field experiments with data from high-throughput molecular marker technologies more fully facilitate marker-assisted selection. Simulation modelling is used extensively, with calibration and validation using observational data. Two outstanding examples, developed in Australia, are

APSIM (Agricultural Production Systems sIMulator) for agricultural production systems and QU-GENE (a software platform developed by the University of Queensland to investigate the characteristics of genetic systems undergoing repeated cycles of selection and mating) for plant improvement systems.

■ Gaining insights and understanding

Various statistical modelling approaches – for example, exploratory data analysis, generalised linear mixed models, pattern and visual analytics and general spatio-temporal (hierarchical) modelling efforts – enable multidisciplinary teams to gain an in-depth understanding of the particular agricultural system. For example, the analysis of germplasm collection data has brought about statistical innovations for analysing large, complex, multivariate data.

■ Decision-making under uncertainty

This involves risk assessment, uncertainty quantification and prediction. In plant improvement programs, breeders need to identify ‘best performers’ and incorporate desired traits into new varieties. Testing across many environments (which vary in both space and time) will enhance prediction of long-term variety performance and is more valuable than additional replication at a single site. Genotyping the entries in these multi-environment trials provides abundant marker data which can be used to make inferences about the accumulation of desirable genes (such as for disease resistance) and their adaptation to the different (stress and management) conditions.

■ Implementation

Once decision-making has been completed, the new statistical design, analytics workflow and/or resulting recommendations can be implemented or adopted (for example, selected germplasm

released to the market). Increasingly implementation of statistical design and analytics has required software to be integrated into the workflow of organisations, as well as ensuring appropriate statistical capability is nurtured in the implementing organisation.

■ Monitoring and evaluation

Whereas years ago the process may have finished at implementation, it is now critical to monitor and evaluate the final outcomes. This is often done in collaboration with those who invested in statistical science to optimise agriculture and the food supply chain. These could involve government entities (such as Research and Development Corporations, known as RDCs), research organisations, grower group consortiums, or national and international partners. Increasingly statistical science is also being integrated into impact evaluation systems through the development of appropriate lead and lag indicators of impact and methods to track trends in the indicators that showcase the triple bottom line (economic, social and environmental).

These examples clearly show that, like all informatics sciences (statistics, mathematics, ICT, sensing, socio-economics, decision sciences), statistical science has been evolving by becoming increasingly entwined in all aspects of the information and decision-making value chain.

In future, the people working in statistical science – in collaboration with others in agriculture – need to address three big challenges for developed economies like Australia:

1 Enhancing productivity performance

– by concentrating not only on ways to fill the production demand in an efficient manner (for example, efficiencies in processes, new technologies) but also ensuring there are no losses in productive capacity (for example, degraded soil and water, workforce capability) and considering if demand in certain agricultural/food products needs to be adjusted (for example, increase in crops that provide cellulose via crop residue or woody tissue as a source for biofuels).

2 Creating competitive, value-added products and services to the global market

– small to medium enterprises (SMEs) having the ability to operate as service providers where their value proposition goes

beyond only selling products to include providing information to ensure productivity performance of individual enterprises, industry and government.

3 Fostering collaboration and connection to address significant global challenges – notably using digital technologies and smart information use to enhance collaboration and connection with the aim of optimising agriculture and food supply chain.

Food security in the developing economies must not be neglected, with these three challenges having linkages and relevance to their future prosperity. Many statistical scientists are involved in research related to developing capabilities in components of agriculture and the food supply chain in those countries (in partnerships with colleagues there). We applaud and encourage their participation, in the past, currently and in the future.

A key player internationally is the CGIAR Consortium, an organisation that advances international agricultural research for a food secure future for the poor. Major players in Australia are ACIAR (the Australian Centre for International Agricultural Research) and the Crawford Fund (an ATSE subsidiary).

Readers can see findings of the Crawford Fund's *Doing Well by Doing Good* Task Force on pages 15 and 16 of this issue of *Focus*.

We agree with the suggestion that there should be a closer alignment between

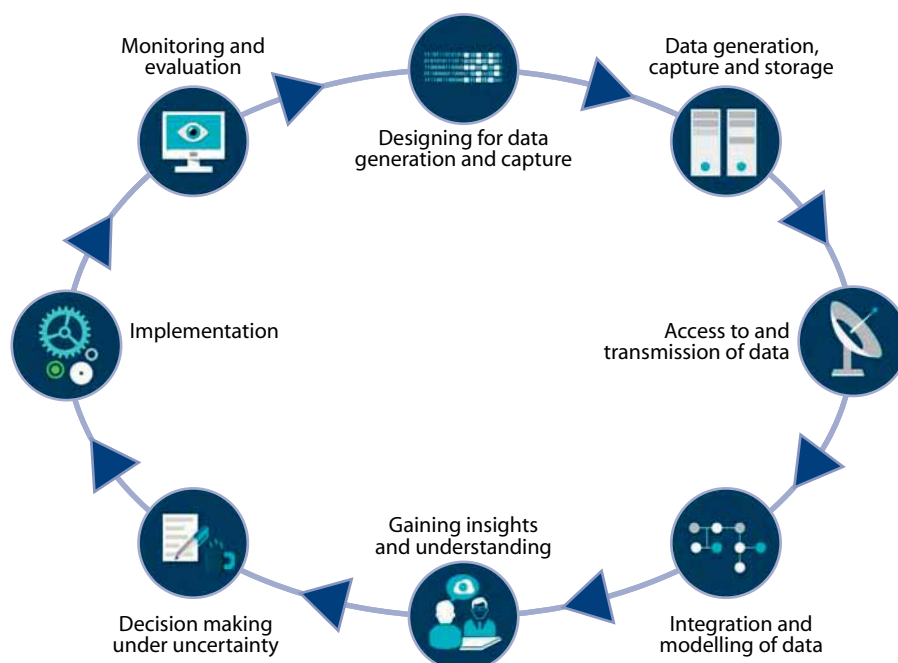
Australian investment in international agricultural research and areas that are of high priority for Australian agriculture.

But we propose that these areas include the key steps in the information and decision-making value chain needed to optimise agriculture and the food supply chain – statistical science's contribution to food security here and abroad.

PROFESSOR KAYE BASFORD FTSE is President of the Academic Board at The University of Queensland. As Professor of Biometry, her leadership and impact is at the interface of statistics and quantitative genetics, particularly through the analysis and interpretation of genotypic adaptation in large-scale plant breeding trials. She is on the Board of Trustees of the International Rice Research Institute, a Director of ATSE and the Crawford Fund (chairing the Queensland Committee), and is a former President of the International Biometric Society (IBS) and the Statistical Society of Australia Incorporated (SSAI).

BRONWYN HARCH FTSE is Chief of the CSIRO Division of Computational Informatics. Her research impacts have been at the boundary of statistical and agri-environmental sciences. She has worked on the statistical design of landscape-scale sampling protocols and monitoring programs, as well as spatio-temporal modelling of agri-environmental systems. Her leadership of research in digital technologies and data-intensive science continues to deliver impact to industry, society and the environment. Currently, she is President of The International Environmetrics Society (TIES) and a panel member for the CGIAR's Mid Term Review.

Figure 1 Information and decision making value chain



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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Food security and nutrition are closely linked

The greater part of the global population is not starving and is reasonably free of associated nutrient deficiencies. While hunger still exists at an unacceptable level, massive famines are uncommon.



By David Topping
david.topping@csiro.au

It is impossible to dissociate food security and nutrition. The traditional view of the two had more to do with insecurity than stability and is summed up (relatively simply) as “making sure that the population has enough to eat”.

Generally, this meant grain-based foods as various cultures adopted agriculture as a better means of guaranteeing the food supply than hunting and gathering.

When crops fail due to climate or pests, major social dislocation follows – the collapse of the Mayan empire, the Irish potato famine and the rice riots in Japan in the 1930s. There is nothing new in this as hunger is a key driver for human behavior and major famines generally enter into folklore.

While there is a general belief that drought has been responsible for most of the trouble (understandable in Australia), damp and cold have probably made their contribution too. For example, it is likely that the Reign of Terror during the French Revolution had its origin in the Great Fear, which was probably due to fungal contamination of wheat after an extended period of high rainfall.

Such contamination is virtually unknown today and our current relatively safe and assured global food supply is quite unusual historically. Although there are concerns about the world reserves of grain, it is unlikely that there will be famine on a significant scale in the near future at least. Projections for the world population are quite a different matter and it is abundantly clear that if this occurs, then there will have

to be a radical change of gear in production.

Population growth depends on more food being available. Britain was the home of the Industrial Revolution but it was actually preceded by an Agricultural Revolution in the 1700s and the beginnings of the industrialisation of production all the way from the paddock to consumers, who became concentrated in cities and towns.

The mechanisation of agriculture led to greater efficiency which, together with the introduction of new vegetables, enabled the greater production of farm animals for food. With time, these changes flowed on to the mass production of consumer foods which were sold firstly in specialised shops and then subsequently in the supermarkets which are now a feature of everyday life in industrialised countries.

Before the development of modern food preservation technologies the options were very limited. Our constant supply of shelf-stable consumer foods and commodities such as meat, fish, fruits and vegetables is due, basically, to the abolition of seasonality.

In a very real sense, this is an industrial triumph. In general, the greater part of the global population is not starving and is reasonably free of associated nutrient deficiencies. While hunger still exists at an unacceptable level, massive famines are uncommon.

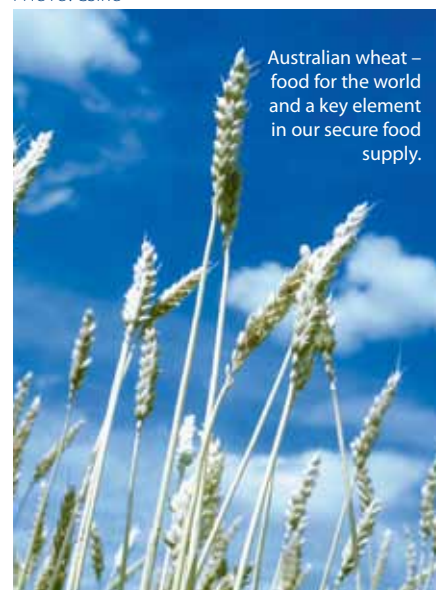
This can only occur provided the modern system of food production is maintained, given the fact that most projected population growth

will be in cities where the inhabitants cannot grow their own food.

Nutritionally, there is a very great deal to be said for the status quo. In Australia, as in many other similar countries, the provision of more energy means that individuals are now taller and stronger than was the norm. There is also considerably greater diversity in the range of foods available, both in terms of cultural origins as well as the ingredients from which they are made, which has the benefit of reducing the risk of micronutrient (vitamin and mineral) deficiencies and also optimising their utilisation.

These deficiencies still exist in the Third World and, to a lesser extent, developing countries. However, there has been a major change in the balance

PHOTO: CSIRO



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

of the macronutrients (fats, protein and carbohydrates) with considerably less starch and more simple carbohydrates in processed foods. These foods are also generally highly refined, which means that they are not only relatively energy-dense, they are also higher in metabolisable energy than comparable foods used to be and also lower in fibre. (Metabolisable energy refers to that energy in a food that can be digested and absorbed by an individual.)

It means that now consumers recover more of the energy than they used to, which could contribute to the key nutritional issues facing affluent industrialised countries and also developing countries with greater personal wealth. These problems include obesity, certain cancers (especially colorectal cancer) and type 2 diabetes and are increasing at an alarming rate in countries such as China and India.

Obesity is a physical manifestation of an excess of energy intake over expenditure and is a recognised problem. However, there are more than 190 million Chinese people with diabetes and the rate is rising as it is elsewhere.

One of the contributors to the problem seems to be the fact that the food industry has managed to abolish staling (the process of food going 'stale') very successfully.

This has the unforeseen effect of abolishing the conversion of starch to a form of fibre (resistant starch) which appears to be pivotal to human health. In effect, these diseases of affluence reflect a nutrient deficiency.

CSIRO is working to develop new forms of starch to enable the development of foods enriched with this important nutrient.

DR DAVID TOPPING FTSE is a Chief Research Scientist at CSIRO Animal, Food and Health Sciences in Adelaide and his current research interest is the health potential for gut health of processed foods, particularly dietary carbohydrates (fibre, resistant starch and oligosaccharides), probiotics and dietary fats. His research aims to improve public health in Australia with respect to the major diet-related diseases by: the identification and substantiation of foods with defined health benefits; establishing the functionality of foods and dietary components with potential health benefits in the fields of cancer, cardiovascular disease, diabetes and gut health; and contributing to the development of a regulatory framework relating to health claims associated with new functional foods.

Warming "will disturb soil nutrient balance"

An increase in aridity due to global warming will disturb the balance of nutrients in the soil and reduce productivity of the world's drylands, which support millions of people, a landmark study predicts.

The research was conducted by a global collaboration of scientists who carried out the same studies of 224 dryland sites in 16 countries on every continent except Antarctica.

In Australia, woodland sites in NSW near Mildura were studied by the University of NSW's Adjunct Professor David Eldridge, of the School of Biological, Earth and Environmental Sciences, who is a member of the international research team.

Other sites included areas of the Negev Desert in Israel, the Pampas lowlands in Argentina and the Altiplano highlands of Peru. Rainfall at the sites ranged from 100 to 800 millimetres per year, and all soil samples were analysed in the same laboratory in Spain.

The research shows that increasing aridity is associated with a reduction in carbon and nitrogen in the soil and an increase in phosphorus.

"Drylands cover about 41 per cent of the Earth's land surface and support more than 38 per cent of the world's population," Professor Eldridge says.

"As the world's population grows, people will increasingly rely on marginal lands – particularly drylands – for production of food, wood and biofuels. But these ecosystems will be severely affected by imbalances in the cycle of carbon, nitrogen and phosphorus.

"Plants need all of these elements, in the correct amounts and at the right times, but increasing aridity will upset this balance, leading to a breakdown in essential soil processes."

The research shows that increasing aridity is associated with a reduction in carbon and nitrogen in the soil and an increase in phosphorus.

A dryland site in Peru that was sampled.



PHOTO: DELDRIDGE

Proof positive: Australia still doing well by doing good



By Neil Andrew
ncandrew@bigpond.net.au

2013 was a tumultuous year for agriculture in Australia and 2014 looks like being just as active as the National Farmers' Federation goes about taking forward its Blueprint for Australian Agriculture and the Government initiates its discussion paper, Green Paper and White Paper, all focused on Australian agriculture.

I trust that this very important work will take proper account of the international dimension of Australian agriculture, especially in respect of research and development as well as extension, or RD&E.

Australia is no longer a colony in an economic sense and no longer an island in a research sense. Our agricultural researchers, and the specialised fields they are in, have long been part of domestic and international networks. Australia was a founding member of the FAO. We cannot stop the world and get off, nor can we be research isolationists carrying out all essential research ourselves. The world storehouse of research capital is just too big to ignore.

Australia has to be intimately involved in international agricultural research if we are to have the keys to this storehouse. Moreover, Australia is a major beneficiary of such research including a large chunk of it that is funded by the Australian aid program.

Benefits include those provided to Australian farmers through new varieties of grains and plant varieties from research undertaken at CIMMYT (the International Maize and Wheat Improvement Center), ICRISAT (the International Crops Research Institute for the Semi-arid Tropics) and ICARDA (the International Center for Agricultural Research in the Dry Areas) and also to the Australian research institutions, which are strengthened through their

engagement in the international networks.

Our domestic markets may not be large enough to enable the multinational private sector to invest in research unique to our environment or in many countries in our region. We have to find new ways of encouraging them to do so, perhaps as part of an international or regional grouping with interests in dryland and semi-arid agriculture.

Australian investment in international agricultural research helps ensure food security and farm productivity, for this country and for the world. It leads to increased food and incomes for

hungry and poor people in developing countries, who mostly live in rural areas. By improving their farming methods and skills, Australia is also supporting regional economic growth and peace.

The Crawford Fund *Doing Well by Doing Good* Task Force's report considered benefits accruing to Australia and developing countries from our aid program. While international agricultural research in general, and ACIAR's program in particular, should be aimed primarily at improving economic welfare in developing countries, it is in the nature of knowledge in agriculture, drawing

The findings of The Crawford Fund's *Doing Well by Doing Good* Task Force, released in December, will be the focus of a major advocacy and media effort to explain the benefits to Australia of international agricultural research. The full report, a four-page summary and a review of published analyses of costs and benefits to Australia are available to download on its website (www.crawfordfund.org).



Neil Andrew (left) presents the report to Crawford Fund Chairman, the Hon John Kerin AO.

on the skills and expertise of Australian researchers, that it can serve the interests of Australian producers as well. Our study shows convincingly that it does.

The Fund's commissioned high-level review demonstrated an impressive return on investment of between 50:1 and 70:1 by ACIAR (the Australian Centre for International Agricultural Research) and research partners in Australia and developing countries.

This return:

- came from a sample of just 10 per cent of ACIAR's total bilateral research program;
- greatly exceeds the total investment in ACIAR-led bilateral research to date; and
- has also led to advances in the productivity of Australian agriculture, although most of it results from increased farm incomes in developing countries.

The report has numerous examples of benefits.

Australian grain growers benefit financially every year by around 10 times the value of our annual investment in international agricultural research centres. They achieve higher yields and/or have lower costs through using new seed resources ('germplasm') that we receive from CGIAR Centres (formerly the Consultative Group on International Agricultural Research), particularly

CIMMYT, ICRISAT and ICARDA supported by ACIAR, GRDC (the Grains Research and Development Corporation) and other Australian research groups that appreciate the benefit they receive through such support.

The Global Crop Diversity Trust, the World Vegetable Centre, CABI (the Centre for Agricultural Bioscience International) and other international centres also share their knowledge and resources with Australia. IFPRI (the International Food Policy Research Institute) has done some great work, often in partnership with Australian researchers, on policy and trade issues in food security.

In the protection of orchard and field crops, through work by ACIAR (and partners), Australia now:

- is better protected against some potential invading mite pests of honey bees (CSIRO) which would threaten pollination, and banana skipper from Papua New Guinea (CSIRO); and
- understands control of fruit fly pests, including species entering Australia and those formerly preventing our growers' access to the Japanese mango market.

It is imperative to food security that researchers, the world over, are abreast of the rapid changes and possible breakthroughs in modern agricultural science. Developing-country postgraduate students and scientists sponsored to visit Australia engage in research here.

Both ACIAR and the Crawford Fund play roles in this regard. Australian researchers work abroad gaining experience and capacity which yield unquantified benefits to Australia. These include:

- fresh thinking on Australian agricultural issues;
- new scientific tools and insights from developing countries which can also apply in Australia;
- opportunities to understand and prevent threatening biosecurity risks; and
- high credibility for Australia in international scientific forums and peer-group meetings, and among internationally respected colleagues.

The aim of aid-supported agricultural research must always be to increase global food security and reduce poverty by enhancing agricultural productivity and by increasing international trade. This research can also enhance the potential for Australian agricultural production, research capabilities and biosecurity.

The report points to ways that ACIAR's great work can further support Australian farmers and consumers.

We suggest there should be a closer alignment between ACIAR programs and areas that are of high priority for Australian agriculture. The National Primary Industries RD&E Framework is a useful platform upon which international agricultural research could build.

Funding for ACIAR should increase at least at the level of inflation and by more as returns to its investments are confirmed. ACIAR might be encouraged to put some numbers on claimed benefits to Australian research capacity from our engagement in international agricultural research. And the scope for greater private sector participation, perhaps through public-private partnerships, should be actively explored.

THE HON NEIL ANDREW AO FTSE is a citrus grower from South Australia who spent 21 years in Federal Parliament as the Member for Wakefield (1983 to 2004) and served as Speaker from 1998 to 2004. He grew up in the South Australian Riverland, where his family had interests in horticulture. He was an active participant in the SA Agricultural Bureau movement, and was Chairman (1980–82). In 1975 he was awarded a Nuffield Agricultural Scholarship to make an overseas study tour. He served as Chairman of The Crawford Fund 2005–10 and chaired The Crawford Fund's Doing Well by Doing Good Task Force.

The Crawford Fund was established in 1987 as an ATSE initiative and maintains close ties with the Academy. Named in honour of Sir John Crawford AC CBE to commemorate his outstanding services to international agricultural research (IAR), it works to encourage support for IAR by governments and the private sector in the belief it holds the key to alleviating rural poverty in developing countries and also benefits Australia. The Fund also has a training program involving Australians with people from developing countries.

Two Crawford Fund board members, Professor Kaye Basford and Dr Tony Gregson, who each chair State Committees of the Fund, have also written theme articles for this edition of *Focus*.

For readers with an interest that extends beyond agriculture, the Fund's policy briefs and conference proceedings, such as from its 2013 mining and agriculture conference, may also be of interest as they place agricultural research in the wider context of national and international economies. It may also be of interest that we will jointly undertake with the Syngenta Foundation a project in 2014 on demand-led research and the 2014 annual conference is titled *Ethics, Equity and Efficiency: Feeding the 9 Billion Well*.

ATSE opposes R&D tax law changes

Proposed changes to Australia's tax laws regarding research and development deductions for large companies are flawed and should not be passed by the Parliament, the Academy has said in a submission to Government.

In a submission to the Senate Standing Committee on Economics on the Tax Laws Amendment (Research and Development) Bill 2013 ATSE said passing the Bill would have severe impacts on Australia's productivity.

ATSE says technological innovation, underpinned by research and development (R&D), is a key driver of productivity and international competitiveness for Australia. Large companies play an important role in driving innovation through investment in R&D.

Given the priority to lift productivity in Australia, ATSE says it has strong concerns regarding the adverse impact that this Bill is likely to have on large companies and their investment in R&D in Australia.

The Academy urges the Committee to:

1 Ensure that a rigorous, evidence-based approach is taken in analysing the Bill and that the same approach is reflected in the Committee's report to the Senate.

2 Recognise and take steps to avoid unintended consequences of driving R&D investment offshore (including loss of employment and related spillover as well as negative impacts on some large Australian companies).

ATSE says that, given the likely impact of the Bill on industry R&D expenditure in Australia, and the fact that the R&D tax incentive program has only been running for a short period of time, it is important that the Committee has access to detailed information regarding the cost, benefits and impacts of the Bill, including whether there could be adverse impacts on the profitability and productivity of businesses that perform R&D in Australia.

ATSE questions the Bill's explanatory memorandum's claim that the Bill will have no impact on business expenditure on R&D in Australia, noting that a significant proportion of business expenditure on R&D in Australia is performed by large companies (more than 68 per cent according to the *Australian innovation system report 2013*).

"The majority of these large companies are multinational and are capable of shifting their R&D to whichever country makes the most sense. By removing access to the incentive, some large companies that currently invest in

R&D in Australia may move some or all of this investment overseas," ATSE's submission says.

"This would have a major multiplier effect as it is the R&D personnel in large companies that form the receptors (or bridges) between industry and the academic and government-funded researchers.

"We will therefore see a double impact, not just the research shifting offshore, but a loss of those capable and experienced in collaborating with our universities and CSIRO and the like."

ATSE's submission says Australia's poor position in terms of collaboration can only get worse as a result, expressing its concern that there would be significant and adverse impacts from this Bill on investment in R&D in Australia.

It also says large companies undertaking R&D in Australia employ Australian graduates, including PhDs. "When these employees move jobs, they take with them R&D skills and knowledge, often to the benefit of other companies operating in Australia. They also collaborate and contract with Australian firms, resulting in transfers of technology and expertise.

"The employment of researchers by large companies generates secondary employment in the community. For every researcher employed it is likely that, on average, at least two other jobs are created in the Australian economy, ranging from technicians to service

equipment to local retailers.

"Australia could lose some of these benefits if this legislation drives large companies to invest in R&D elsewhere," the submission says.

ATSE says there is no evidence for the Bill's Second Reading Speech claim that the Bill "reduces waste by ensuring that government incentives for R&D are applied in a more effective way".

"Australian governments, over the years, have sought to encourage foreign firms to invest in Australia and to undertake R&D here. Large foreign firms have been the target of marketing campaigns by Invest Australia and Austrade. This Bill could be counterproductive to these efforts by implying that foreign firms cannot rely on stable R&D incentives in Australia," ATSE says.

"Finally, we are dismayed at the prospect that large Australian companies will be particularly disadvantaged because all their income (whether earned in Australia or overseas) is likely to be assessable, while for foreign companies undertaking R&D here, only income derived in Australia will be assessable," ATSE says.

"It is difficult to understand how the Parliament could agree to such a discriminatory approach."

The full submission is on the ATSE website at Publications/Submissions

ATSE talks collaboration

ATSE's Senior Research and Policy Officer, Dr Lauren Palmer, presented a paper on the importance of international interdisciplinary collaboration in science, technology and innovation policy at a recent two-day Melbourne School of Government conference, 'Public Policy in the 'Asian Century': Advancing Opportunities, Meeting Challenges, Preparing for Change'.

She drew on examples, such as Boeing, the Large Hadron Collider project and the Human Genome project, and covered barriers to collaboration, the importance of linking researchers and policy-makers, ATSE's international activities, and how Australia can expand and increase its international collaboration capacity.

(From left) Lauren Palmer, Professor Paul Jensen (Melbourne Institute), Ms Jenny McGregor (CEO Asialink) and Dr Guanhua Wan (Asian Development Bank).



Nearly 200 at AGM Oration Dinner

The 2013 AGM and Oration Dinner at the Adelaide Hilton Hotel was a highlight of the Academy year, with more than 180 Fellows and guests attending. It was an outstanding evening.

New Fellows were presented with Fellowship certificates and welcomed to the Academy in a well-managed ceremony involving the President, Dr Alan Finkel AM FTSE, and the Vice President Membership, Professor Mike Miller AO FTSE.

The South Australian Division did an admirable job in achieving an attendance of more than 180 and the organisation of the dinner was a tribute to the energy and expertise of the Academy staff.

The dinner came at the end of a two-day program which included the Academy's 11th Assembly, a joint meeting of Division and Forum Chairs, Workshops on Manufacturing and Health Technology, the Annual General Meeting and the New Fellows Forum.

Academy President Dr Alan Finkel welcomed guests and set the tone for an enjoyable evening, which Fellows used to renew acquaintances and friendships and get to know the new Fellows attending.

The opening address by the Hon Tom Kenyon MP, Minister for Manufacturing,



Minister Kenyon addresses the dinner.

Innovation and Trade and Minister for Small Business, was challenging – he addressed some of the real issues of research translation and set the scene for the 2013 Oration.

Professor Tanya Monro delivered the 2013 Oration, which focused on research issues, translation of research into commercial results



Alan Finkel presents a Fellow's certificate to Dr Sue Barrell.

and the prospects for enhancing the national conversion rate of research. She also gave a neat insight into her role at the Institute for Photonics and Advanced Sensing (IPAS) at the University of Adelaide.

A survey of those who attended the event indicated that most rated it highly.

ATSE addresses 'fracking' issues

The Academy used the Australian Council of Learned Academies (ACOLA) shale gas report as the basis for its submission to the Inquiry into the Implications for Western Australia of Hydraulic Fracturing for Unconventional Gas, conducted by the WA Legislative Council's Standing Committee on Environment and Public Affairs.

ATSE highlighted in its September submission that – as well some of the key issues related to hydraulic fracturing for unconventional gas addressed by the inquiry – potential impacts on human health, greenhouse gas emissions and the issue of gaining and retaining the social licence to operate were also important.

The ACOLA report,



Engineering Energy: Unconventional Gas Production – a study of shale gas in Australia, reviewed the range of issues facing shale gas development in Australia and made 51 key findings considering the potential environmental, social and economic impacts of an Australian shale gas industry.

The report also addresses the potential impact of hydraulic fracturing, the regulation of fracking chemicals, and the use of groundwater, brackish water and 'produced' water for fracking operations.

Key elements of the ATSE submission included the impact on land use, chemicals regulation, the use of groundwater and produced water, and land reclamation.

The ATSE submission is on the ATSE website at Publications/Submissions

ATSE AND EA SIGN AGREEMENT

The Academy and Engineers Australia have signed a five-year Cooperation Agreement with the intention of pursuing the national interest by jointly promoting the role of technological science in ensuring an innovative and prosperous Australia. The agreement was signed by the presidents Dr Marlene Kanga and Dr Alan Finkel.

It commits to collaboration activities including joint submissions and reports, and joint seminars or workshops when appropriate. It provides for both organisations to work jointly to promote STEM subjects at primary, secondary and tertiary levels and to advance engineering education nationally. It also provides for annual meetings between the organisations' presidents and CEOs and promotes regional contact and cooperation between organisation members.

The agreement extends an arrangement between the organisations dating back to 1986.

Key steps to translate our research into economic benefit



The 2013 ATSE Oration was delivered at the Hilton Hotel, in Adelaide on 22 November 2013. The Orator was Professor Tanya Monro FAA FTSE, Director of the Institute for Photonics and Advanced Sensing (IPAS) and Professor of Physics, University of Adelaide.

Australia should move the translation of research into economic benefit much higher up the priority ladders of the nation's best institutions and its research funding agencies.

The nation has a future in higher-value advanced manufacturing because it has extraordinary research that has the capacity to develop new products and services that don't necessarily suffer as badly from Australia's high cost environment and distance to market as other, lower-value manufacturing.

Australia needs to make changes so that successful entrepreneurs – from whom philanthropy flows – feel they succeeded because of the system, not in spite of it.

These were some of the key messages from Professor Tanya Monro's 2013 Academy Oration in Adelaide.

"We need to nurture entrepreneurship in our researchers and increase our risk tolerance in our universities," she said.

"We should be celebrating individuals and

universities who have failed because they have tried – not hiding them and being embarrassed about them. We want entrepreneurial students. We need entrepreneurial professors so that the entrepreneurial students know to be entrepreneurial and have a go.

"We also need greater mobility between industry and our research organisations – giving industry a chance to see the enormous value staff with PhDs can bring, and creating more diverse job opportunities for the students we train."

Professor Monro noted the obsession with research publication – particularly citations: "h' factors and 'm' factors obsess us," she said – and asked "Why don't we create a 't' factor? – a 'translation' factor which would be a quantitative measure that you can look up on Google Scholar that measures patents, licences, number of companies formed, contract research, expert witness cases and consultancies, for example. This could measure a researcher's engagement with translation in a way that is ascribed to the individual."

Australia needed to recognise commitment to translation structurally, she said.

"People do what is measured – no more so than researchers. Hence my suggestion of the 't' factor, to complement extending the ERA (the Excellence in Research in Australia) research management initiative to include the impact factors. I don't think impact factors in ERA alone is enough – while they would be valuable they would also be a retrospective measure."

Australia needed to support the development of clusters in and around niche areas of internationally recognised strength, but ensure it did not make silos.

"Cutting things up by industry sector often does exactly that because if you have an enabling platform technology, such as photonics, for example, it could feed into all of them and you may have missed an amazing opportunity."

"Nurturing the growth of clusters of companies around our core research strengths will create high-value jobs for our PhD graduates and bring tangible benefits to the companies."

"If we want to stop complaining about the fact that we have great research and don't get great economic benefit from it we need the courage to change this together," she said.

The 2013 Oration is on the ATSE website at Publications/Orations.

Two new Forums being launched

The Academy will launch two new Forums in 2014 – Mineral Resources and Infrastructure.

These will work alongside the Academy's established Forums – Energy, Education, Water and Health Technology – and Advisory Groups (Climate Change Impact and Innovation).

The ATSE Board approved the formation of the two new Forums at its 17 December meeting.

The Board has also welcomed the concept of an Agriculture Working Group, which is in the process of being formed.



Infrastructure issues are critical – Melbourne's Eastlink.

ATSE driving a health focus on technology

The Academy is working with the Victorian Government and the health industry to improve Australian healthcare through enhanced use of technology.

The aim is to develop a trial program that fully integrates the exchange of patient/client personal, medical and clinical data between private sector carers and public sector hospitals and provide access to the data outputs of the proliferating health/medical devices available.

The parties feel this approach will avoid collision with the monolithic nature of proprietary systems but significantly reduce the costs and time delays of having to revalidate all information at the provider interfaces.

It is also anticipated to allow quicker and more appropriate intervention by accessing current health/medical information.

The initiative grew from an approach to the Academy by the Victorian Government's Department of State Development, Business and Innovation (DSDBI) for the 2013 ATSE Clunies Ross Awards program to include a series of five workshops exploring opportunities for innovation and collective action that would improve the delivery of healthcare in the home.

This fitted well with the Awards focus, which – to quote Awards Chair Mr Bruce Kean AM FTSE – celebrates the achievements of “those who have brought significant benefits to the Australian community through technological innovation”.

It also fitted the Academy focus on the

pressing need to lift productivity across all sectors of the economy – not least in the healthcare sector, which is already grappling with a growing ageing population and rising costs, added to which is the burden of chronic disease and trauma. ATSE believes that innovation in the production and delivery of goods and services is a key driver of improved productivity.

A recent report by the Victorian Auditor General into the hospital HealthSMART system also highlights the need for integration to reduce costs and improve service levels. The common theme is the integration of data across all participants in this field with the patient/client, not regulatory and funding compliance, as the driver.

Recent research by the British Medical Association indicates that the use of personal medical devices and telecare monitoring, integrated into a telehealth system, has the potential to deliver:

- 45 per cent reduction in mortality rates;
- 20 per cent reduction in emergency admissions;
- 15 per cent reduction in Accident and Emergency hospital visits;
- 14 per cent reduction in elective admissions; and
- 14 per cent reduction in hospital bed days.

The workshops and associated small working groups identified that:

- 90 per cent of patient/client contact is with private carer organisations and 10 per cent with public sector hospitals/medical providers – governments are actively transferring ‘care’ activities to private providers and actively seeking to reduce hospital readmissions;
- all entities in this field use proprietary systems that do not provide cross-communication – systems are often focused primarily on responding to funding and regulatory compliance reporting;
- there is no widespread use of technology-enabled devices, which are often resisted by patients/clients – the most widely used devices are passive personal health and fitness monitors;
- the service needs of aged care, trauma and chronic disease patients/clients are not integrated as they are driven by different funding and regulatory bodies; and
- the dominant medical/clinical issues to be addressed in aged care (the largest and a growing sector) were considered to be hospital readmission, medication errors and falls in the home.

The current project evolved through the workshop process after two approaches were examined and put aside.

The initial focus was on improving the use of health and medical monitoring devices by building or retrofitting a show home that

ACOLA launches report on interdisciplinary research

The Character of Interdisciplinary Research, a new report released in January by the Australian Council of Learned Academies (ACOLA), identifies the characteristics of successful interdisciplinary research and outlines the barriers that must be overcome in order for it to grow in Australia.

“Future societal challenges are complex, multifaceted, unpredictable and not confined to a single research discipline. Consequently, the need for an interdisciplinary approach, particularly for visionary research that attempts to break new ground, will continue to increase,” says Mr Peter Laver AM FTSE, chair of the Project Steering Committee.

The Character of Interdisciplinary Research

is the second in a series of three reports, *Making Interdisciplinary Research Work*, being undertaken by ACOLA, looking at how Australia can encourage and maximise outcomes from interdisciplinary research.

The report identified 13 characteristics of successful interdisciplinary research and 12 critical challenges including training, funding and institutional structures. The report focuses on interdisciplinary research looking at sustainability, with a series of environmental case studies included throughout.

Findings will be road-tested in the third phase, *Assistive health technologies for independent living: a pilot study*. The pilot study comprises a ‘live’ scenario exploring

the benefits of applying an interdisciplinary approach to the key challenge of enabling elderly and disabled Australians to live at home longer through the use of innovative technologies.

Making Interdisciplinary Research Work is supported by the Australian Research Council.

The Character of Interdisciplinary Research report is at www.acola.org.au

ACOLA enables Australia's four independent Learned Academies to come together to help inform national policy development and develop innovative solutions to complex global problems and emerging national needs.

PHOTO: ISTOCKPHOTO



The changing face of healthcare.

would act as a technology platform for the development and demonstration of healthcare devices and systems. However, this still left the central problem of no communication between the various providers.

The second focus was on the concept of developing a communications gateway to facilitate interoperability using open-source software and existing technologies such as:

- tablets with dedicated health apps;
- mobile phones and GPS to provide mobility; and
- local storage of personal data to meet privacy needs.

It became clear that this approach would have to become the National Healthcare

Systems Standard to justify the very high cost and was beyond the capacity of this group.

The current project involves a consortium of the Royal Freemasons Hospital, Medtech Global (a technology-based medical services provider) and Swinburne University formed to develop and deliver the project Integration of Technology Enabled Services. Three hospitals are also being invited to participate.

The next step is to prepare a detailed business case and to seek funding for a two-year trial.

Enquiries can be directed to the ATSE Health Forum (Ms Sarah Parker, 03 9864 0914, sarah.parker@atse.org.au).

HEALTH TECHNOLOGY BARRIERS MUST GO

More than 30 Fellows attended the ATSE Health Technology workshop in Adelaide in November, linked to the ATSE AGM and Assembly, which centred on disruptive technologies and the opportunities they can provide for society.

Delegates agreed current and emerging disruptive technologies – including cochlear implants, spinal cord stimulators, pacemakers, visual prostheses, fall monitors and other monitoring technology – could have many benefits for society.

While these technologies have huge potential to assist the aged and disabled to live independently and improve their quality of life, the seminar agreed there are many barriers to the commercialisation of such technologies, including access to funding and differences in culture, which need to be reduced.

The workshop discussed:

- the need for Australia to create an environment that encourages individuals to be entrepreneurial;
- the need to foresee the potential future medical needs of society (future prevention);
- the reduction of regulatory barriers to innovation and encouraging researchers to commercialise products;
- the benefits of keeping development and production of products in Australia;
- the results of gaining and retaining confidence in companies that can assist with funding and commercialisation; and
- the need to reduce the funding divide for medical research.

International endorsement for STELR approach

The International Science, Technology and Innovation Centre (ISTIC) for South-South Cooperation under the auspices of UNESCO has written a letter of endorsement of the STELR Project.

ISTIC acts as an international platform for south-south cooperation in science, technology and innovation and makes use of the network of the G77 plus China and the Organization of the Islamic Conference.

The overall goal of the Centre is to increase the capacity for management of science, technology and innovation throughout developing countries.

"ISTIC sees education as vital for emerging economies to be able to build capacity in

science and technology. To this end, ISTIC promotes the use of Inquiry-Based Science Education (IBSE)," wrote Dato' Dr Samsudin Tugiman, Director of ISTIC.

"ISTIC recognises that the Science and Technology Education Leveraging Relevance (STELR) program of the Australian Academy of Technological Sciences and Engineering is a world leader in inquiry-based, hands-on science education for secondary schools.

"Science is inherently global, thus a good teaching initiative such as STELR will be as fundamentally suitable for students in emerging economies as it is for students from Australian and other wealthy economies.

"Students the world-round learn better if

they are interested in the topic and actively engaged. We were impressed to see that the STELR topics are modern and relevant to students' lives, thus interesting. As well, because STELR is hands-on and inquiry-based, all students will be actively engaged."

"Science is inherently global, thus a good teaching initiative such as STELR will be as fundamentally suitable for students in emerging economies as it is for students from Australian and other wealthy economies."

– DR SAMSUDIN TUGIMAN

Three critical areas for advanced manufacturing

Academy Fellows identified three areas of critical importance to which national manufacturing reforms must be directed when they met at a seminar in Adelaide in November linked to the ATSE AGM and Assembly.

The Advanced Manufacturing workshop agreed the key areas were:

- nurturing our emerging “clever” SMEs to replace old manufacturing enterprises;
- adopting new disruptive technologies; and
- driving collaboration between the research sector and industry.

More than 40 Fellows participated in the ATSE seminar, chaired by Dr Mike Heard FTSE, which featured presentations by Mr Bruce Grey FTSE (Advanced Manufacturing CRC) and Mr Zoran Angelkovsky (META), followed by a panel discussion also involving Mr Paul Sandercock (PPS Global Pty Ltd) and Ms Leonie Walsh FTSE (President, Australasian Industrial Research Group).

The seminar agreed that national policy, investment and reforms to nurture Australia’s “clever” SMEs were absolutely vital. New business mechanisms were also required, including tools such as technology roadmaps and intellectual property landscape mapping to help firms leverage competitive advantage and pre-empt the market.

Fellows attending the seminar agree that new manufacturing would be driven by innovation and shaped by new disruptive technologies that would fundamentally

alter business practices – things like additive manufacturing (3D printing), biomanufacturing and increased use of industrial robotics, which are already driving rapid change in global manufacturing from customised products and services to new business models.

They noted that Australia lags in this transformation, which must be industry-led, with key national reforms required to stimulate change.

The workshop also agreed that much better collaboration between industry and publicly funded research organisations is critical for the translation of research into economic benefit for Australia. It noted that accessible data on the research capabilities of public institutions and businesses and on the technology needs

ATSE is committed to developing evidence-based options to address these challenges. For example, ATSE is participating in the ACOLA project ‘The role of science and research and technology in lifting Australia’s productivity’. ATSE and SA’s Department of Manufacturing, Innovation, Trade, Resources and Energy held a full-day workshop on The Transformation of South Australia’s Manufacturing Sector in Adelaide on 12 February 2014.

of industry does not exist, but is vital to identify intersections of competitive advantage as opportunities for collaboration and innovation.



Titanium horseshoes – a hot-off-the press example of 3D printing.

PHOTO: CSIRO

Submission suggests innovation actions

The Academy has recommended to the Federal Government a number of low-cost, low-risk actions to build innovation in Australian firms as a first step in boosting industry-led productivity in Australia.

In a submission to the Australian Government’s Economic Review of South Australia and Victoria, ATSE noted the challenges to realising manufacturing opportunities, including Australia’s relatively high-cost environment and limited comparative advantage in the manufacturing sector.

- ATSE suggested that the Government:
- assist state government efforts to grow technology-based SMEs, currently underway in South Australia and Victoria;
 - incentivise collaboration between

businesses and between businesses and publicly funded research organisations to lift innovation;

- focus on ways to de-risk innovation for high-growth companies, particularly SMEs, through support for international collaboration; and
- foster advanced manufacturing companies for high growth in Australia through supportive and rewarding incentive mechanisms.

Academy president Dr Alan Finkel AM FTSE and Dr Bruce Grey FTSE, Managing Director of the Advanced Manufacturing CRC, met the Review Panel in Melbourne in January to detail ATSE’s views.

ATSE’s submission noted that innovation and technological advances were driving rapid

changes in manufacturing and this had resulted in the emergence of new business models and market structures and customised products and services.

It noted that advanced manufacturing techniques – such as additive manufacturing (3D printing), biomanufacturing and the use of industrial robotics – offered important opportunities for Australia.

Significant opportunities are emerging for Australian firms to participate in strategic areas of global value chains (GVCs) where the highest returns are possible, for example in design, product development and provision of services.

The submission is on the ATSE website at Publications/Submissions.

Clark and Smyth named in Top 100 mining women

CSIRO CEO Dr Megan Clark FTSE and Toro Energy Chair and ANSTO Board member Ms Erica Smyth FTSE have been named as in the world's Top 100 inspirational women in mining, by the UK's Women in Mining group, a non-profit organisation that aims to promote the value women bring to the minerals sector.

Dr Clark is Chief Executive of CSIRO – Australia's national science agency and one of the top 10 applied research organisations in the world. Previously VP at BHP Billiton Australia, she is also Chair of the Mining for Development Advisory Board for AusAid and sits on the Prime Minister's Science, Industry and Engineering Council.

Originally a geologist, Ms Smyth holds numerous roles in the governance of organisations, including Chair of uranium company, Toro Energy, and directorships of the Diabetes Research Foundation and Royal Flying Doctor Service.

Other women from the Australian mining industry and associated fields listed included:

- Margaret Beck, Vice President of Finance (Iron Ore), BHP Billiton;
- Heather Bell, Regional Manager NSW for Resource Development, Rio Tinto Coal;
- Vicky Binns, Vice President (Coal Marketing), BHP Billiton (Singapore);
- Sue Border, Director/Principal Geologist, Geos Mining;
- Fran Burgess, General Manager, Projects and Group Metallurgy, Perilya Ltd;
- Meredith Champion, Partner, Allen & Overy;
- Sandra Collins, Operations Manager, MMG, Century Mine;
- Joanne Farrell, Global Head, Health, Safety, Environment and Communities, Rio Tinto Group;
- Marnie Finlayson, General Manager, Port Maintenance, Rio Tinto Iron Ore;
- Donna Frater, Principal Geologist, BHP Billiton;
- Jodie Gray, Pit Technician Supervisor, Newmont Boddington Gold;
- Vanessa Guthrie, Managing Director, Toro Energy Ltd;
- Michelle Iles, Principal Advisor Environmental Studies, Energy Resources of Australia;
- Sinead Kaufman, General Manager, Rio Tinto;
- Alison Keogh, Principal Consultant, AMC Consultants;
- Kirsty Liddicoat, Site Senior Executive and Mining Manager, CopperChem Ltd;
- Kalpana Maharag, Mine Development Superintendent, Rio Tinto;

- Tina Markovic, General Manager, BHP Billiton;
- Jane McAloon, Director Governance and Group Company Secretary, BHP Billiton;
- Lisa Mirtsopoulos, Dump Truck Operator and Trainer, Newmont Mining;
- Alison Morley, CEO, Brumby Resources;
- Pamela Naidoo, Manager, Technical Services, Northparkes Mine, Rio Tinto;
- Sabina Shugg, Head of Mining, Momentum Partners;
- Julie Shuttleworth, General Manager, Cloudbreak Mine, Fortescue Metals Group;
- Andrea Sutton, CEO & Managing Director, Energy Resources of Australia;
- Myfwangy Szezanowski, Production Supervisor, Callide Coal, Anglo American;
- Vanessa Torres, Head of Group Investments and Value Management, BHP Billiton; and
- Donna Weston, Port Safety Officer, Rio Tinto Iron Ore.

COLLETTE McKAY AIMS TO ENHANCE HEARING

Professor Colette McKay has accepted a Senior VESKI Innovation Fellowship worth \$200,000 over three years to enhance the

effectiveness of cochlear implants.



Colette McKay

Before returning to Victoria, Professor McKay was the Chair of Applied Hearing Research at the University of Manchester from 2007–13. On her return to Melbourne, she became the Leader of Translational Hearing Research at the Bionics Institute, Melbourne.

Professor McKay was the only international researcher to receive the Senior VESKI Innovation Fellowship for 2013. This three-year Victorian

Government grant will support her research into developing an objective and automated cochlear implant programming system to help deaf children obtain optimal hearing from their cochlear implant.

Following implantation and 'switch on', a cochlear implant must be programmed to convert sounds into patterns of electrical stimulation across the electrodes within the inner ear. To program the device to produce stimulation within an audible and comfortable range of loudness the implant recipient must provide feedback. This process is not feasible in infants and is also a time-consuming process in older children and adults.

Professor McKay's research aims to develop an objective way of measuring the auditory brain's response to electrical stimulation so that programming can be automated, accurate and efficient, as well as tailored to the individual.

The Victorian Government VESKI innovation fellowship scheme attracts researchers and their expertise, experience and networks back to the state. It seeks to foster an innovation economy through identifying globally competitive individuals and leading researchers and bringing them to Victoria for the benefit of the Australian economy.

The VESKI Chair is Professor Snow Barlow FTSE, Professor of Horticulture and Viticulture at the University of Melbourne. Professor Andrew Holmes FRS FAA FTSE, incoming President of the Australian Academy of Science, is a Board member and VESKI alumni.

VESKI Innovation Fellows, apart from Professor Holmes, include Professor Michael Cowley FTSE and Professor Edwin van Leeuwen FTSE.



Megan Clark



Erica Smyth

Nancy Millis Medal struck

The memory of world-renowned microbiologist Professor Nancy Millis, an Academy Fellow for 35 years, has been marked by the establishment of the new Nancy Millis Medal by the Australian Academy of Science.

Nominations closed on 10 February for the medal, which recognises outstanding research and exceptional leadership by early- to mid-career Australian women in any branch of the natural sciences.

The Nancy Millis Medal for Women in Science honours the contributions made by the late Professor Nancy Millis AC MBE FAA FTSE and recognises her importance as a role model for women aspiring to be research leaders.

Award recipients will have established an independent research program and demonstrated exceptional leadership. The award is restricted to candidates who are normally resident in Australia and for research conducted mainly in Australia.

Professor Millis introduced fermentation technologies to Australia, created the first applied microbiology course taught at an Australian university, and co-wrote the standard text *Biochemical Engineering*. Professor Millis also worked tirelessly to establish links between universities and industry.

She completed a degree in agriculture in Melbourne in 1945 and a PhD at Cambridge in 1952, and became senior demonstrator at the University of Melbourne in 1952, then lecturer in 1954. She was awarded a personal chair in 1982 – only the fourth woman appointed professor at the university – and held it until her retirement.

Professor Millis became the Chancellor of La Trobe University in 1992, a position she held until her retirement in 2006. She made a huge contribution to molecular genetics in Australia by serving as Chairman of the initial Monitoring Committee for recombinant DNA and then as the first Chair of the Genetic Manipulation Advisory Committee.

Professor Millis joined ATSE in 1977 and served on Council (1979–82) and the Crawford Fund Board (1994 to 2001).

MYRA KEEP NAMED WA SCIENCE AMBASSADOR

Professor Myra Keep from the University of Western Australia, has been named WA's 2013 Science Ambassador of the Year.

The Award recognises an individual scientist who has demonstrated commitment to undertaking meaningful science advocacy and

engagement in addition to their core research activities.

Over the past 10 years Professor Keep has developed a range of geological research, teaching and outreach activities in East Timor through significant collaboration with all levels of government, schools and the local community. She initiated the program and has raised all the required funds for her research and engagement activities. Her outreach activities have included the training of young geologists, students, government officials and industry personnel, leading to significant community development.

She has been instrumental in the development of student links between UWA and East Timor. A number of these students have now returned to East Timor as trained geologists, having completed degrees in Australia and elsewhere.

She was announced as WA's Science Ambassador by the WA Premier and Minister for Science, Colin Barnett, at a presentation ceremony in Perth.

LYN BEAZLEY TO CHAIR NEW BRAIN CENTRE

Former Western Australian Chief Scientist Professor Lyn Beazley AO FTSE has been named Chair of the new ARC Centre of Excellence in Integrative Brain Function, led from Monash University, which will study the basis of attention and decision-making.

The Centre of Excellence will support neuroscience researchers tackling the challenging problems involved in understanding how the human brain works. The centre will combine techniques for analysing brain anatomy and physiology with advanced computational techniques, to uncover the fundamental principles of brain function.

Professor Beazley stepped aside from her former role at the end of December.

She is a Vice Patron of the Royal Society of Western Australia (since 2008), which is celebrating its centenary in 2014, and serves several boards spanning radioastronomy, renewable energy and bionic vision.

SINDEE-ROSE WINS APPEA AWARD

Sindee-Rose Wong, a Curtin University student who is now in the final year of a five-year double degree in Chemical Engineering and Chemistry, has been awarded APPEA Oil and Gas Engineering Scholarships for 2013.

Sindee did not follow a traditional pathway into engineering. She worked for six years in customer service after leaving school before enrolling at an adult college to complete physics, chemistry and mathematics courses in order to realise her long-held dream of becoming an engineer.

She is a Curtin University student mentor for first-year science students. Each semester, she offers guidance and information to between 10 and 20 students, helping them settle into university life in a program that has been shown to improve retention rates. She is also the Vice-President of the Curtin University Division of Engineers Without Borders.



Sindee-Rose Wong



(From left) Colin Barnett, Myra Keep and Donna Faragher MLC (Parliamentary Secretary to the Premier).

A technology breakthrough 50 years in the making



By John Hart-Smith
john.hart-smith@bigpond.com

More than 50 years ago, in 1962, Monash University was in its infancy. The first student intakes were arriving, with departments having tens of students each – or less – rather than the hundreds or thousands of today. There were very few buildings and there was even ample free parking!

Monash, where this research investigation began, was a very great change from the busy campus at The University of Melbourne, where I completed my BMechEng (Hons) in 1961. I was one of the first postgraduate students at Monash – the first in the Department of Applied Mechanics, in the School of Engineering – and I chose Monash because I was very impressed by my supervisor, Professor J.D.C. Crisp, one of the five founding professors, and his choice of available research topics.

During my studies at Monash, I became convinced that the reason for the great disparity between the theoretical predictions of the buckling stress in thin elastic shells and the test data was not the fault of the experimentalists, as is commonly believed to this day, but of the theoreticians. Understandably, this was a contrarian viewpoint.

The experimental evidence about shell buckling was, to me, overpowering. I devised new shell buckling equations, which explained how the addition of internal pressure to cylindrical shells compressed longitudinally would progressively increase the buckling stress and change the form of the buckling mode from square diamonds, for unpressurised shells, to circumferential rings for highly pressurised shells, with the buckling stress being doubled in the process.

The classical analysis had predicted that the two buckling stresses would be the same, at the higher value. In other words, despite the experimental evidence to the contrary, the predicted buckling

stress was fixed, with and without internal stabilising pressure. The mean test value of the buckling stresses for unpressurised cylinders was exactly what I predicted it should be, half the classical prediction. And the effects of internal pressure followed the trend of my analysis, too.

Nevertheless, I was unable to convince the experts of the day. My work on buckling was then interrupted by a 40-year career in the aerospace industry in America.

Most of my time at what became McDonnell Douglas (when the McDonnell Aircraft Company took over the Douglas Aircraft Company) was spent on R&D contracts for NASA and the US Air Force on composite structures, particularly joints, because there was a lot of money available to fund such research. There was none to work on thin-shell buckling, because nobody but me saw any need to improve the analyses.

The subject languished, except for when my knowledge of thin shell behaviour was applied to a USAF-funded all-bonded metallic fuselage barrel for a large transport aircraft, for which I proved that, even without rivets, the cabin pressure would not blow the skin off the

adhesively bonded stringers and frames.

The computer code I developed to characterise the pinch-in of the pressurised skin by the internal stiffening elements was used worldwide. After it was taken over by McDonnell Aircraft, I finally got a chance to design a pressurised aircraft fuselage structure for Boeing, including designing the lap splices and frame-stringer intersections that never wore out on test in an all-metal fuselage concept that was lighter and less expensive than any other such structure.

The knowledge acquired at Monash about large-deflection structural analysis was crucial. The equations used are exactly the same as for buckling, but with tensile applied loads. That was the first large US transport aircraft with the cabin pressure loads analysed nonlinearly.

After retiring in 2008, I resumed my studies on thin shell buckling – knowing that the classical analyses were fatally flawed, and that no one else would accept my theories, so I needed a new starting point for the analysis.

Therefore, I extended the flat-plate buckling analyses for the various geometries and applied loads, thinking that no



John Hart-Smith (right) receives his AGM Michell Award from Mr Earl Heckman, then Chair of the Mechanical College Board of Engineers Australia.

one would dare challenge them, which enabled me to successfully analyse far more problems than before: spherical shells under external pressure; externally compressed cylindrical shells; longitudinally compressed cylinders with and without internal pressure; and, with a lot of difficulty, torsional buckling of cylindrical shells.

These solutions predicted that the buckling stress for the spherical shell should be only *half* what had been

predicted by the classical analysis, while the buckling stress for cylinders under external pressure was only *one-third* of what had previously been believed. In addition, it showed that the classical solution had the wrong buckling mode – two wavelengths around the circumference instead of one.

I found the solution for longitudinally compressed cylinders, analysed by starting from the flat-plate buckling solution, just as I had predicted more than 45 years

earlier. Then, the challenge became one of predicting the same result starting from a thin-shell theory instead.

However, I had one remaining problem. My predictions agreed well with the test data – the discrepancies had largely disappeared – but the solution for the buckling of cylindrical shells under external pressure disagreed totally with the classical analyses for the buckling of arches and rings. So a new solution was needed for those problems, too.

This final analysis identified an even more critical error in the classical shell-buckling analyses. The 19th century pioneers rightly identified that buckling was essentially an inextensional process, meaning that the circumference did not change in length during buckling, but they characterised this by arbitrarily adding in-plane displacements to neutralise the linear pre-buckling membrane stresses caused by the radial displacements. This notion of inextensibility *should* have been expressed in terms of the absence of first-order in-plane displacements in the nonlinear equations *during* buckling. Any small membrane stresses induced during buckling are governed by the standard equilibrium equations, and should *not* be defined by any arbitrary inextensibility ‘requirements’. One consequence of this error is violating the conditions of equilibrium. The origin of this error is a misinterpretation of work by Lord Rayleigh, in 1894, when he was

THE AGM MICHELL MEDAL

The Award perpetuates the memory of Anthony George Maldon Michell (1870–1959), an outstanding Australian mechanical engineer.

Mitchell was a consulting engineer in the field of hydraulics and pump design and in conjunction with his investigations of lubrication at the beginning of the century he invented the tilting-pad thrust bearing, a momentous technical innovation. His other notable achievements were the invention of his viscometer, the development of hydraulic power transmissions and the design and development of a series of crankless engines. He was elected a fellow of the Royal Society in 1934 and was awarded the Kernot Medal in 1938 and the James Watt Medal in 1943.

The AGM Michell Medal is awarded by the Mechanical College of Engineers Australia and was established in 1978. Past winners include many Fellows and deceased Fellows:

- | | |
|--|--|
| ■ Dr John Hart-Smith FTSE (2012); | ■ Professor Ray Stalker AO FAA FTSE (1991); |
| ■ Dr Alan Baker FTSE (2011); | ■ Emeritus Professor Alan Roberts AM FTSE (1989); |
| ■ Dr Francis Rose FTSE (2007); | ■ Dr John Allen AM FTSE (1988); |
| ■ Emeritus Professor Peter Joubert OAM AM FTSE (2001); | ■ Professor Russell Luxton FTSE (1986); |
| ■ Professor Roger Tanner FRS FAA FTSE (1999); | ■ Professor PT Fink CBE CB AO FTSE – Foundation Fellow (1985); |
| ■ Mr Don Fry AO FTSE (1997); | ■ Professor JD Crisp AM FTSE (1984); |
| ■ Mr Stuart Morgan AM FTSE (1994); | ■ Dr AE Bishop AM FTSE (1982); and |
| ■ Professor Bill Melbourne FTSE (1993); | ■ Emeritus Professor KH Hunt FTSE (1979). |

SCIENCEALERT WINS FIVE MILLION FANS

Australian science website ScienceAlert, founded by Fellow Mr Julian Cribb FTSE and which features the scientific achievements of the nation's universities and research agencies, has achieved the milestone of five million worldwide fans on social media site Facebook.

Set up eight years ago to build a global audience for Australian R&D, Canberra-based ScienceAlert uses a mix of news stories, feature articles, videos, images and comment to engage, enthuse and inform a worldwide audience that is mainly aged 14 to 25 years.

“Thanks to our growing fan base and their networks on Facebook and Twitter, stories featured on ScienceAlert can now reach 10 to 15 million people around the world each week,” says ScienceAlert Managing Director Chris Cassella. “According to PageData, the leading international source of independent Facebook page metrics and trends, we also have 250,000 Australian fans and they in turn are helping us to reach one to two million Australians. This is great news for Australian science – at a time when reportage of science in the traditional media is flagging.”

In the ‘Asian century’, ScienceAlert has become the largest outlet for science news in the Asian region, with large followings in countries such as India, Pakistan and the Philippines. Its following on Facebook exceeds

established science media outlets such as New Scientist, Scientific American, LiveScience, Discovery News and ABC Science.

A DISCOVERY THAT CHANGED THE WORLD

The 100th anniversary of the discovery of isotopes might not be on everybody's list of history's greatest moments but few events have had such a large impact on our everyday lives.

As Australia's major producer of radioisotopes for medical and industrial purposes, its significance is not lost on anybody at the Australian Nuclear Science and Technology Organisation (ANSTO).

Our health, the integrity of major structures, our knowledge of history, and science itself have been fundamentally changed by a discovery by the English chemist Frederick Soddy in 1913. His cousin, the physician Margaret Toddy, coined the term isotopes soon afterwards.

Soddy proved the existence of isotopes, or that different atoms can be transformed from one element into another by radioactivity and associated phenomena, resulting in different numbers of neutrons per element. The discovery of the isotope brought with it the possibility of separating a chemical element into several isolated components that could be used in different ways.

investigating the acoustics of bells. He distinguished between the low frequencies associated with predominantly radial displacements that caused bending and the high-frequency vibrations associated with predominantly in-plane displacements that involved no bending. Others misapplied his analyses to shell buckling and thereby concluded that the correct solution for the buckling of circular tubes under external pressure was merely a rigid-body motion, and adopted the next higher (elliptical) buckling mode as the right answer.

During October 2013, I had a Eureka inspiration that should finally resolve all the confusion about this subject.

It began with the geometrically nonlinear small-strain thin-shell theory I derived as a PhD student 50 years earlier from Novozhilov's Theory of Elasticity, by starting from the equilibrium and strain-displacement equations for an infinitesimal element. As a shell theory, these equations contain both linear and nonlinear terms (products of unit forces and strains or rotations). If the nonlinear terms are removed, what is left is essentially the classical linear theory that applies prior to buckling.

At the onset of buckling, those linear membrane forces will be in perfect balance with the applied loads. Their net effect is zero, at that point. If those terms, and the associated loads, which are then frozen, are removed from the three equilibrium

equations, what is left ought to be the 'nonlinear' equations governing the buckling process. Since the membrane forces must be frozen, to ensure that they continue to match the applied loads, the buckling equations are actually linear, consisting of products of constant forces and either strains or rotations, plus the transverse shear forces, which did not participate in the linear analysis, that are used to introduce the bending moments into the buckling analysis in the customary manner. The first two of these, in the in-plane (surface) directions are found to be identities, while the third one is exactly what I had deduced by extending flat-plate buckling theory, in *every* case.

These buckling-stress equations differ fundamentally from the classical governing equations. Here, the buckling loads are resisted by bending moments, as is generally accepted for the buckling of columns and flat plates. (Only insignificant second-order membrane stresses are induced for shell buckling.) In the classical analysis, shell-buckling loads are (wrongly) predicted to be resisted by first-order post-buckling membrane forces as well, which is why the estimated buckling stresses are too high.

Establishing the shell-buckling equations by this two-step approach also exposed just what went wrong with the classical analyses, and the new approach should be beyond reproach. It agrees with the test data.

Time will tell what eventually happens. Perhaps the blind focus on not questioning the governing equations and spending all the time, effort and budget on 'imperfection-sensitive structures' – as the explanation for the large discrepancies between test and theory – could be diverted to something more productive than finding the form and size of imperfection needed to reconcile tests with bad theories.

In reality, the imperfections the pioneers sought to characterise were in the theories, not in the tests and structures.

Regardless, once the shock of such a radical change in the status quo wears off, academia will suddenly find itself with thousands more subjects for PhD candidates to study. This is fitting, since that is where this saga began, 50 years ago.

DR JOHN HART-SMITH FTSE was the first PhD in the Monash University Mechanical Engineering Department in 1968. In 1988, he was awarded Monash's second Higher Doctorate, in Engineering, based on his work in industry on joints in aircraft structures. He became an ATSE Fellow in 1998. In 2012, he received Engineers Australia's AGM Michell Award. He also won the the Institution of Mechanical Engineers (IMechE) Charles Sharpe Beecher Prize, in 1989 and 1995, and its Thomas Hawksley Gold Medal in 1995. He is a retired Senior Technical Fellow at Boeing, having spent 40 years in the US aviation industry with Douglas, McDonnell Douglas and Boeing.

This discovery led to a new understanding of the periodic table and, in addition to nuclear power, has had profound implications for many scientific disciplines and underpinned many industrial applications.

The World Nuclear Association lists a number of peaceful applications of radioisotopes, including:

- assessing the efficiency of fertiliser;
- managing insect populations without use of insecticides;
- preserving food;
- managing water supplies;
- sterilising medical products; and
- powering smoke detectors.

Gauges containing radioactive sources are used widely in industry to check levels and density of gases, liquids and solids; radioisotopes are also used by radiographers to check the effectiveness and safety of pipes, railway tracks, turbines and engines; and analysis of radioisotopes is also crucial for determining the age of rocks and other material of interest to geologists, anthropologists and archaeologists.

When used in radiopharmaceuticals, the isotope Lutetium-177 is able to target tumours in the body and is used in treatments of neuro-endocrine cancer. Researchers at ANSTO and many other organisations are exploiting the properties of isotopes like this to look for new cancer treatments, diagnostic applications and a broad range of other exciting uses.

THE CURIOUS COUNTRY

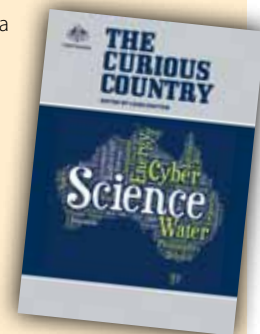
Chief Scientist Professor Ian Chubb AC has launched the free eBook *The Curious Country*, published by ANU E Press.

"Earlier this year (2013) my office commissioned a survey asking people what issues they wanted science to address, what if anything concerned them and what inspired them," Professor Chubb said.

The results of the survey framed the narrative for the eBook – *The Curious Country* – a series of essays edited by Ms Leigh Dayton, former Science Editor of *The Australian*, and available for anyone to download (www.chiefscientist.gov.au/2013/11/the-curious-country).

"Science shapes our lives in so many ways – the technology we use, the food we eat, the medicine we take. But do we think about it? This book seeks to tell some of these stories in an engaging way that we hope people will enjoy reading," Professor Chubb said.

Chapters include 'Promoting health and wellbeing', 'Managing our food and water assets', 'Sustainable energy and productivity' and a final chapter titled 'Curiosity'.



China's Yutu can learn from our lunar dust discoveries



By Brian O'Brien

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With the December landing of the Chinese Chang'e 3 rocket carrying a lunar rover named Yutu China now joins the US and Russia as the Big Three powers in space, capable of landing rover vehicles at precise spots on the Moon, with all that implies when a thermonuclear device can be put on the pointy end of a great big rocket.

In 1966, when, as Professor of Space Science at Rice University in Houston, Texas, I invented a match-box sized Apollo Dust Detector Experiment which hitchhiked on Apollo 11 and was put on the Moon by Buzz Aldrin, I never dreamed that in the 21st century the 270-gram box of three solar cells and three thermometers might be important for the first Chinese lunar rover, Yutu (Jade Rabbit).

There are two reasons why Yutu might benefit, if it's not too late, from our discovery of the long-term accumulation of dust on the surface of the Moon. With seven solar cells making measurements every 54 seconds during each Lunar Day of about 350 hours (from 1969–76) near the Apollo 12, 14 and 15 landing sites, we reported that the net accumulation of dust caused about a 10 per cent reduction in their voltage output, up to about 100 micrograms per Earth year, accumulating at up to about one millimetre of dust each 1000 years.

This means that the iconic footprint of Buzz Aldrin in Moondust will endure for at least 10,000 years, about the same time in the future as the end of our last Ice Age in the past. That means about the same length

of time as the Great Barrier Reef has existed or humans have been settled in Ireland.

Yutu has a great deal of shiny gold foil to help reflect raw sunlight that heats the surface of the Moon to about 120 degrees Centigrade at Lunar Noon. However, one nasty problem with powdery lunar dust is that even a very very thin layer, a monolayer of dust particles only one particle deep, or about half the thickness of a human hair, will make the gold foil much less shiny, causing overheating as happened with Apollo.

I assume that, frustrating as it may be, the Chinese controllers on Earth will drive Yutu very slowly so that its six spinning wheels throw very little of the inescapable dust upwards in the vacuum, with no air to slow it down.

The new US lunar orbiter LADEE is now starting to measure both lunar atmosphere and 'dust' at heights of about 10 to 20 kilometres. Both the Yutu landing engine gases and any resultant 'puffs' of surface dust on impact-landing should be useful events for LADEE.

There is often great fuss and drama about the need for innovation, and productivity and all that, with which I broadly agree. But it's nice to know that sometimes even one spark from Heaven to a then-young Aussie, just before dinner on 12 January 1966, on National Airlines flight 58 travelling home to Houston after two days of heavy conferences in Los Angeles, might be of value. Sometime.

It reinforces the old saying 'Science is glorious entertainment'.

PROFESSOR BRIAN O'BRIEN was Deputy Chief Physicist of the Australian National Antarctic Research Expeditions in Melbourne 1958–59 before becoming Assistant then Associate Professor of Physics (1959–63) and Professor of Space Science (1963–68) at the State University of Iowa. He was Principal Investigator for the Charged Particle Lunar Environment Experiment (CPLEE) on Apollo 13 and 14 and the Dust Detector Experiment (DDE) on Apollo 11, 12, 13, 14 and 15. He was the first Director of Environmental Protection and Chairman of the EPA in WA (1971–77) before establishing a strategic and environmental consultancy. He was appointed Adjunct Professor of Physics at UWA in June 2009.

The Lunar Dust Detector, attached to this experiment package left by the Apollo 12 astronauts, made the first measurement of lunar dust accumulation. As the matchbox-sized device's three solar panels became covered by dust, the voltage they produced dropped.

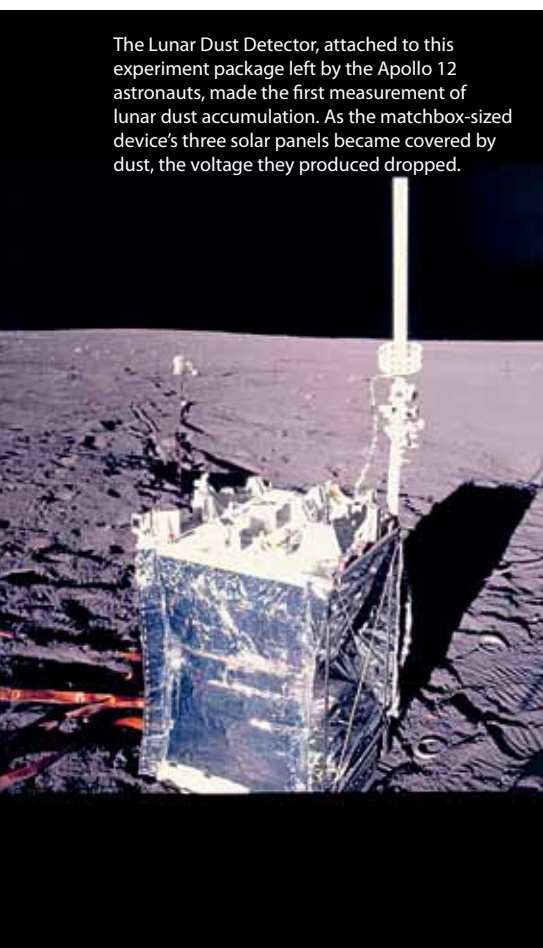


PHOTO: 123RF.COM

PHOTO: NASA

The American Geophysical Union recently chose our current moondust research publication in *Space Weather* for its 'Research Spotlight' – very pleasant news for because we had no research funding for the work, conducted by my colleague and student with double First Class Honours in Science and Engineering, 23-year-old champion athlete Monique Hollick and I, now a 79-year-old Professor of Physics at the University of Western Australia.

Manufacturing, commercialisation and jobs growth

Various sources of funds are available to companies once they have demonstrated that they can generate revenue, but very few to pre-revenue companies.



By Alexander Gosling

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Australia would benefit substantially if it could achieve three things:

- reverse the decline of manufacturing industry, and accelerate its transformation to adapt to the 'third industrial revolution';
- generate jobs growth especially in those sectors where work is rewarding and is likely to retain or attract highly skilled individuals in a globally competitive jobs market; and
- improve the national return on the significant investment of taxpayers' money currently allocated to research in public-funded research organisations.

These three strategic objectives are linked and meet, or at least overlap, in the zone of technology-based start-ups and SMEs.

There is little evidence that large established manufacturing firms have much appetite to invest in growth or transformative new technology in Australia – very much the reverse. In almost every sector we see downsizing or shutdowns. Only new companies are primarily focused on investing in new products, processes and manufacturing concepts.

It is often reported that in developed economies job growth comes from the SME sector. And it is reasonable to argue that jobs in technology-based start-ups will be more stimulating and rewarding than those in locally static or declining industries.

Start-ups, having no lock-in to older manufacturing technologies via legacy investment in plant and machinery, will naturally be inclined to adopt latest technologies and thus be more globally competitive and 'future proof'.

Broadly, new technology created by our research organisations can be commercialised either by license-out to an established (usually foreign) firm, or by means of a start-up or spin-out set up

(usually locally) for the purpose. Where the latter is practicable, it is clearly likely to deliver more value to the Australian economy, and to lead to subsequent ongoing collaboration between the research organisation and the new company.

Overall, maximising the emergence and successful development of technology-based start-up companies is a powerful way to advance the three objectives.

Several strengths

There are several strengths in the Australian system that we can build on:

- it is well recognised that we have excellent research capability in our public-sector organisations – these generate world-leading research outcomes relevant to a wide range of industries;
- Australians as individuals are innovative. The culture and environment are rich in the factors that research has shown

are critical to encouraging individuals to be creative and to attracting and retaining creative individuals. This combines with the Australian 'have a go' attitude to generate useful innovative concepts and solutions to real-world needs or opportunities. There is a long list of commercially successful technologies or inventions that were created in Australia;

- Australia is a relatively entrepreneurial country, usually ranking high in the Global Entrepreneurship Monitor's annual league tables;
- Australians are keenly aware of the rest of the world, and technology-based start-ups are likely to be 'born global', at least insofar as the vision of the entrepreneur is concerned; and
- there is a significant volume of private sector money in the Australian economy, looking for suitable investment



Collaboration between the University of Melbourne and Mondelēz sweetens the corporate results.

opportunity – this applies both to the institutional and to the individual sector.

Major obstacles

The major obstacle to the emergence of larger numbers of early-stage, high-growth companies (the next generation of organisations like Tenix, ResMed, Vision Systems Ltd, Cochlear, Memtech, Varian) is lack of appropriate funding for early-stage companies.

Specifically, the unserved part of

Therefore, any Australian start-up or pre-revenue company faces a very real prospect of having to leave the country to raise the funds to go forward.

Opportunity space

Put simply, the opportunity is to make it attractive for appropriate private-sector investors to direct a proportion of their available funds to equity investment in early-stage, potentially global and high-growth, technology companies.

Today's high-growth technology-based start-ups will become the established firms of the future, replacing those that decline or leave Australia, and generating growth in a changing global technological and economic environment.

the 'IP-to-IPO' journey is that stage immediately following the end of the publicly funded research, where a start-up has been formed but needs significant funding to advance the technology to launch-readiness and to develop its business commercially – famously known as 'the valley of death'.

Various sources of funds are available to companies once they have demonstrated that they can generate revenue, but very few to pre-revenue companies.

Of those that do exist:

- 'business angels' typically cannot provide the amount of funding needed to develop and launch a significant new product;
- Commercialisation Australia (CA) provides some support, but applications for the larger grants have a lower chance of success and importantly CA does not cover R&D, which is usually the central need for this early stage; CA also provides only 50 per cent of the funds required so the applicant has to have at least half the funding already available;
- the R&D tax offset provides very useful gearing, but only for those who have the funds already available to do the R&D in the first place and to fund their operations until the offset is received from ATO the following year; and
- in theory, some venture capital (VC) firms do operate in this domain but in practice they often show a preference for cases where there is already a revenue stream. In any case Australia is not well populated with active VC firms at present.

At present, there are seen to be too few success models and Australian VCs that have operated in this sector have in general not performed particularly well – so the risks are seen as too high by most private sector investors.

We need an incentive to offset this perceived-risk barrier.

A previous example of such an incentive was the Syndicated R&D Scheme. For all its faults, this was assessed as being most successful in mobilising private sector funds to R&D and thereby inducing significant private sector R&D projects that would not otherwise have occurred. A number of today's Australian iconic technology-based companies were launched – or at the very least given a substantial boost – by that scheme.

The incentive should focus more broadly than the Syndicated R&D Scheme, on funding of technology-based, start-up companies for commercial development activities *including* R&D rather than on R&D *exclusively*. In many countries (for example, the UK, the US, New Zealand) 'angel investors' are given some tax incentive or special support for this type of investment.

The incentive should be designed to complement existing programs – notably the R&D Tax Offset cash payment for SMEs, Commercialisation Australia, the IIF programme and the Innovation Precincts programme.

The critical gap is for the first round of funding after a technology is transferred from the research environment into a start-up company – when we need to bridge this funding 'valley of death'.

Measures could focus on special tax concessions for first-round investors in new companies, subject obviously to qualifications to prevent abuse. A very simple model might be that for first round equity investors any eventual capital gains (up to some prescribed ceiling for each investment) would not be subject to CGT. This could suffice in many cases to offset the perceived higher risk of this type of investment, and would have only a modest (and deferred) cost to tax revenue.

This, broadly, would extend the benefits currently enjoyed when investing via an ESVCLP (Early Stage Venture Capital Limited Partnership) program, licensed under the Federal Government scheme to individual angel, private equity or institutional investors when making a direct first-round investment in a qualified start-up.

Sizeable established firms are essential contributors to achieving the strategic objectives – they are the primary employers and the primary routes for technology commercialisation, and it is important that they continue to be so.

But we need also to look further ahead. Today's high-growth technology-based start-ups will become the established firms of the future, replacing those that decline or leave Australia, and generating growth in a changing global technological and economic environment.

Addressing this issue, to encourage and support the flow of technology-based start-ups, is hugely important to our future, to achieve these objectives and to generate quality employment, future large-scale industrial investment opportunity and real wealth for Australians.

MR ALEXANDER GOSLING FTSE has been working in the field of process and product development and related R&D, for clients ranging from high-technology start-ups to 'smoke-stack' industry global companies for nearly 40 years. This has provided an exceptional base of practical experience on what it takes to progress new technologies to commercial success. He was part of the management team that led Invitech first to public listing (as Vision Systems Ltd) and then to its acquisition by the US Danaher group for more than \$800 million. He is a Past National President of the Australasian Industrial Research Group and the Australia-Malaysia Business Council and a Governor of the Warren Centre for Advanced Engineering.

Time to get serious about national disaster mitigation

Budgetary constraints should not be used as an excuse to continue to expose social and economic conditions to the full force of nature without some national investment in mitigation.



By Bruce Thom

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Bushfire – a natural hazard that can become a national disaster.

PHOTO: ISTOCKPHOTO.COM

The Government announced its intention in December to establish a Productivity Commission Inquiry this year into national disaster funding arrangements. The Commission will be asked the best ways to reduce the impact of natural disasters on communities and how they recover in a sustainable way.

It was noted that state emergency services ministers have already expressed their support for an inquiry into disaster expenditure, and that most existing disaster funding models are weighted towards response and recovery instead of longer-term resilience. The proposed Inquiry provides an opportunity for ATSE to offer advice on options facing the nation on disaster mitigation.

There has been little discussion of how we plan and pay for mitigating the adverse impacts of natural hazards. Each year Australian communities incur losses caused by bushfires, floods, coastal storms, hail and other hazards.

Droughts can no longer be regarded as 'indignant surprises' – they are lurking around waiting for the next El Niño phase of the climate cycle to once again achieve full impact. Annual and decadal variability

in climate systems is an underlying feature of our continent and we must prepare for the next wave of shocks and suffering, not just to come along after the event to clean up the devastation. Climate change science is informing us that things are likely to get worse if they are not already.

In 2011 the Council of Australian Governments released the National Strategy for Disaster Resilience. This Strategy has the admirable goal of building disaster-resilient communities across Australia by recognising that disaster resilience is a shared responsibility for individuals, households, businesses and communities, as well as governments. COAG sees "big challenges" acknowledging "that disaster risks are likely to increase and magnify as our climate changes, our population grows and ages, and our society and economy become increasingly dependent on technology".

The report accepts that actions to implement the Strategy will have a cost, but the benefits of improved disaster resilience are expected to exceed the costs. However, the report is silent on what are the expected costs and benefits, and how in particular can the Federal Government

best use its resources to gain those benefits.

Four reports have emerged in 2013 which throw more light on the scale of threats, impacts and costs of natural disasters.

In June, the **Australian Local Government Association (ALGA)**, in its 10-point plan for resourcing community priorities, called on all political parties to commit to a disaster management process that would build capacity in local and regional communities to mitigate the impact of natural disasters. Local government is at the cutting edge for managing impacts and relies heavily on the strict conditions of the Natural Disaster Relief and Recovery Arrangements (NDRRA) to repair damaged infrastructure.

ALGA pleaded for a dedicated program involving local government disaster mitigation works to build resilience and "avoid increasingly costly damage to public infrastructure and private property".

In the same week, the **Australian Business Roundtable for Disaster Resilience and Safer Communities** released a report prepared by Deloitte Access Economics which attempted to quantify

the costs now and into the future. It also advocated a governance model that would improve the nation's capacity to build a more resilient Australia. A key component of the governance model is a mechanism that would ensure "pre-disaster resilience policy coordination" supported by a "National Resilience Adviser" within the Department of Prime Minister and Cabinet.

Especially telling were some of its estimates. For instance, without action, the forecast annual cost in real terms of natural disaster is expected to reach \$23 billion by 2050 (total economic costs today average around \$6.3 billion per year). It indicates that an annual program of Australian Government expenditure on pre-disaster resilience of \$250 million has the potential to generate budget savings of \$12.2 billion for all levels of government, including \$9.8 billion for the Australian Government. Such investment could reduce disaster costs by 50 per cent by 2050. These estimates cannot be ignored.

The third report which commented on these issues is that of the **Productivity Commission, Barriers to Effective Climate Change Adaptation**. The Commission noted submissions from insurers on how much greater is the proportion of Australian Government funding for disaster recovery in recent years than

for disaster mitigation. Between 2005 and 2011 the Australian Government spent \$182 million on mitigation while spending \$6.7 billion on relief and recovery arrangements. The report offers examples of where there have been clear benefits from expenditure by various levels of government on mitigation infrastructure.

In its response to this report, the Australian Government stressed that it had a core role in the "coordination and dissemination of natural hazard information, including flood risk, coastal inundation, bushfires and extreme weather elements". But there was no indication as to how this role would change to meet the "big challenges" noted in 2011 by COAG.

In August, the **Senate Environment and Communication References Committee** released its report, *Recent trends in and preparedness for extreme weather events*. While the report contains some valuable information and recommendations, such as on the need for flood mapping to inform land use planning and on the need to improve building codes, it did not indicate how federal agencies should be organised and funded to address issues raised in submissions and in the other three reports.

While agreeing with the Senate Committee recommendations, the Greens

made some additional comments utilising various insurers' submissions and that of the Business Roundtable. The Greens note that while mitigation expenditure remains around three per cent of what it spends on recovery, this is not "the right balance between preventing and preparing for disasters on the one hand, and responding to and recovering from them on the other". This is a similar conclusion to that of the Productivity Commission.

It is instructive to read the recent studies of the Queensland Reconstruction Authority (QRA) on *Planning for stronger, more resilient floodplains*. The Authority is a significant institutional response to 13 declared flood events between 2009 and 2013 and has committed \$14.5 billion of Federal and State funds to the reconstruction effort. A one-off federal levy on taxpayers was used to assist with this funding which raised \$5.6 billion.

The QRA points to a way forward in its reports by demonstrating advantages of floodplain mapping in supporting the planning process. It offers guidelines that could improve the capacity of planners and policy-makers on development of appropriate land use responses to identified flood hazards. What is pertinent to these studies is the involvement of a federal agency, Geoscience Australia (GA).

INDIAN OCEAN HELPS PREDICT WEATHER EXTREMES

A phenomenon in the Indian Ocean that affects events in south-east Australia is helping to predict extreme weather up to six months in advance. The phenomenon, the Indian Ocean Dipole (IOD), is the difference in sea-surface temperatures between the western and eastern part of the Indian Ocean, and until recently has been one of the most influential but the least understood natural forces affecting

Australia's climate. An international team of scientists, led by CSIRO's Dr Wenju Cai, has confirmed the link.

A better understanding of the relationship between the Indian Ocean Dipole and extreme weather events will enable Australia to better anticipate and prepare for droughts and increased bushfire risk, up to six months in advance of the event.

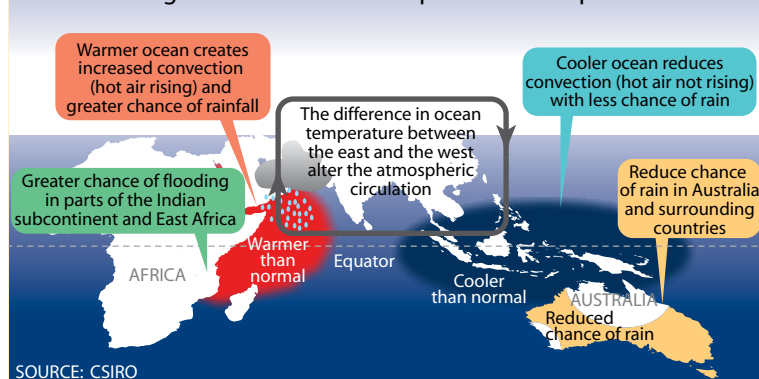
Just as the El Niño Southern Oscillation (ENSO) affects weather patterns across the Pacific Ocean, the Indian Ocean Dipole influences weather and extreme events across the Indian Ocean.

While ENSO fluctuates between 'El Niño', 'neutral' and 'La Niña' phases, the IOD fluctuates between 'positive', 'neutral' and 'negative' phases about every three to eight years.

The positive phase is characterised by greater-than-average sea-surface temperatures, more rain in the western Indian Ocean region and cooler waters in the eastern Indian Ocean. It tends to cause droughts in east Asia and Australia, and flooding in parts of the Indian subcontinent and east Africa.

Dr Cai says the findings provide greater confidence in predicting extreme weather up to two seasons in advance, and furthermore, projecting positive IOD events into the future.

Figure 1 Indian Ocean dipole "Positive" phase



The IOD 'positive' phase.

There has never been a federal agency in Australia with a mandated responsibility to plan, construct and maintain mitigation works. It has largely been left to state governments to perform this role with little consideration for national standards or coordination of effort.

The US Army Corps of Engineers performs this civil role in the US in consultation with the states and local communities. Congress appropriates funds for this purpose to help reduce adverse impacts from floods and coastal inundation and erosion.

Australia has a mixed history of planning for natural hazards. State and local governments often stand accused of not releasing or providing information on risk to communities in the face of pressure from sectors in these communities or the development industry that may threaten property values or investment opportunities.

The work of the QRA supported by GA shows that more consistent standards can be developed. The advantage of having a Federal agency engaged in the mapping and assessing the risk to private and public assets is that it is that further step removed from such pressures and in that sense is better placed to offer transparent hazard and risk information

for use by decision-makers. It can also continue to coordinate research on natural hazards and exposure to risk.

If we are really serious about mitigating risk to natural hazards, it not much use if a Federal agency improves standards and availability of future modelling and mapping of floods and coastal inundation and that information is not applied by states and territories in land use planning and development assessment. Coordination and dissemination of information by itself is not enough. Agreements must be reached as to how federal funds to prepare for disaster are allocated.

One mechanism to explore is that used in the US to allocate funds to the states under the Coastal Management Act. Payments are made on the basis of a state agreeing to implement a coastal plan following Federal guidelines.

A similar scheme if introduced here could mean that each state would agree to revise flood, bushfire and coastal plans to ensure that public and private property developments recognised the potential risk from a natural hazard. Funds could be made available to communities currently at risk following evaluation of options by state and local governments under the agreed criteria to minimise political pressures.

Sufficient funds must be available

on an annual basis, as suggested by the Business Roundtable, to be an incentive for state and local governments to act. Any failure to act could leave the states as the 'insurer of last resort' and not the Commonwealth as it is at present.

These are just a few ideas which could be canvassed in any submission by the Academy to what should be a very important national inquiry.

There are many ways we as a nation can potentially improve Australia's resilience to natural disasters. Budgetary constraints should not be used as an excuse to continue to expose social and economic conditions to the full force of nature without some national investment in mitigation.

PROFESSOR BRUCE THOM AM FTSE is a founding member of the Wentworth Group of Concerned Scientists and the Australian Coastal Society.

He was was Chair of the Federal Government's Coasts and Climate Change Council, and formerly held positions as Chair of the NSW Coastal Council (1989–2004) and the Australian State of Environment Committee (1998–2002). Currently he is assisting the NSW Government as an adviser on coastal planning reform. In 2010 Professor Thom became a Member of the Order of Australia for his contribution to the ecological management of the coastal zone and as a contributor to public debate on natural resource policy.

WA CYCLONES STOKED UP VICTORIAN HEAT WAVES

Cyclones off the Western Australian coast can make Victorian heat waves far worse, according to new research published in the journal *Geophysical Research Letters*.

And, as shown in 2009 when Cyclone Dominic stoked up the heat wave that preceded the Black Saturday bushfires in Victoria, the size of a cyclone is not as important as its location.

"Tropical Cyclone Dominic only reached Category 2 status at its peak but it had powerful amplifying effects for the record-breaking heat wave in Victoria that led to the fatal Black Saturday bushfires," says lead author Tess Parker.

"The cyclone was right in the heart of a 1.5 million square kilometre area that we have identified as a key area for magnifying the impact of high pressure systems that generate Victoria's intense heat waves."

Like many areas in the south-east of Australia, heat waves in Victoria are caused by strong blocking high-pressure systems.

When these large, slow-moving systems hover over Victoria they bring hot northerly winds from the interior of Australia to produce extreme temperatures for several days. These blocking highs are connected to highs or ridges in the upper levels of the atmosphere, known as anticyclones.

"All heat waves in Victoria are associated with upper level

Fire danger.



PHOTO: ISTOCKPHOTO.COM

anticyclones but, while the essential cause of the heat wave is the same, the impact of cyclones on their formation means not all heat waves are created equal," Ms Parker says.

Ms Parker's research was conducted with co-authors Dr Gareth Berry and Professor Michael Reeder.

Understanding the learning process

The University of Queensland has opened the Science of Learning Research Centre, which is funded through the Australian Research Council's Special Research Initiatives scheme.

It will house host researchers in education, neuroscience and cognitive psychology who will work together with teachers to gain a better understanding of the learning process.

The \$16 million Centre will be based around three themes: understanding learning, measuring learning and promoting learning, and its researchers plan to help Australia build a solid scientific evidence base that directly informs teaching practices.

The Centre will be based at The University of Queensland with collaborations at six other Australian universities and the Australian Council for Educational Research. The Centre has also partnered with nine other national and international organisations.

The Centre also employs state-of-the-art brain imaging technology and modelling techniques to synthesise the results across the disciplines. These different but complementary research activities will be essential to investigating and understanding the complexities of classroom learning.

Research in neuroscience will explore how learning leads to changes in the structure of brain cells and in the manner in which cells interact in brain circuits. Research in psychology and cognitive neuroscience will explore how learning is associated with changes in simple behaviours and motivation that are reflected in changes in neural activity in the brain. And at the most global level, educational research will explore learning as the acquisition of complex knowledge and skills and resultant changes in observable behaviour.

IS YOUR BUDGIE LEFT-HANDED?

Unlike people, Australian budgerigars do not have a dominant hand (or claw), scientists studying the brain and visual system have found. Researchers have found that budgerigars, instead of being predominantly 'left-footed' or 'right-footed', change claws according to the task they want to perform.

The discovery flies in the face of a widely accepted scientific view that most social animals, such as honeybees and fish as well as other social birds, use either their left or right side for a particular task.

"Population bias, in which a group of animals share the same 'footedness', is a well-known phenomenon in most social animals, including humans," says Dr Ingo Schiffner from The Vision Centre (VC). "This population bias and side preference has been found in toads, parrots, fish, birds and honeybees."

Professor Mandyam Srinivasan, of The University of Queensland's Brain Institute, says that the current explanation for population bias is that the same 'handedness' or 'footedness' would potentially direct a group of animals to move or respond in the same direction. "This would ensure they all stay with the

group and do not become isolated or vulnerable, for example when being chased by a predator."

While budgerigars stay with the flock when they fly together, the researchers have found that the budgie, when left on its own, does things a little differently – and breaks the accepted rules.

"As the brain of a bird is similar to a human's, we hope that this will improve our understanding of how the human brain works, including what the two hemispheres really do, and why some tasks are partitioned a certain way," Professor Srinivasan says.

TIME TO TALK ELECTRIC CARS, SAYS ESAA

Electric cars have the potential to be faster, safer, quieter and cleaner than conventional vehicles and the energy supply industry believes it's time for a serious public debate on how we can enable their use in Australia.

A new discussion paper released by the Energy Supply Association of Australia (ESAA) highlights three key public benefits from accelerating uptake of electric cars: better environmental performance of Australia's transport fleet, improved efficiency and utilisation of our existing networks, and reduced reliance on imported fossil fuels.

The paper identifies the importance of a 'critical mass' of electric vehicles, which will enable the necessary support services like recharging and after-sales servicing needed to make electric cars a viable proposition.

ESAA Chief Executive Matthew Warren says the car market is fundamentally consumer driven, with the uptake of new technologies such as electric cars driven by key consumer qualities like value, performance, reliability and brand.

"We can make it hard for electric cars, or we can make it easier," Mr Warren says.

"International markets have shown that the fundamental enabler for electric cars is critical mass. Once you have enough electric cars in a market, they create their own infrastructure, their own after-sales support and their own resale market.

"But if we don't find a way of enabling this initial critical mass, then

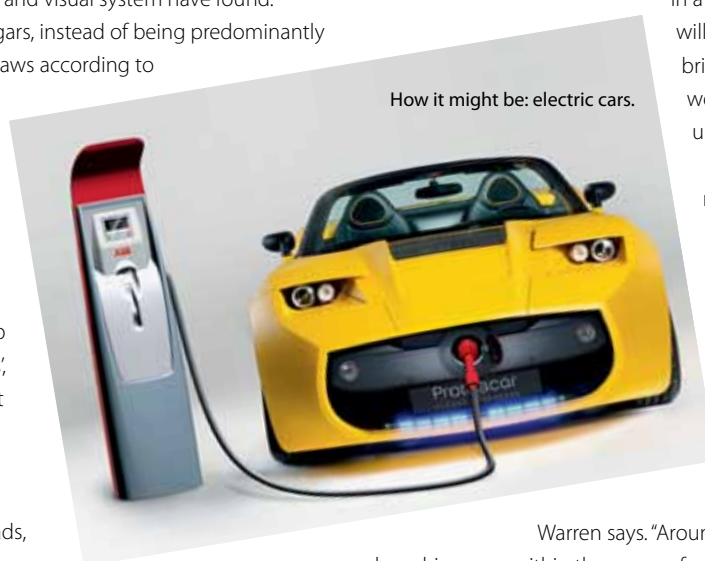
in a small market like Australia we will just discourage car makers from bringing electric cars here, and we may be waiting a long time to unlock the benefits they can deliver."

Mr Warren says in advanced markets such as California an extensive network of car recharging facilities is being supplied by retailers such as McDonald's, Target and Ikea, which saw an opportunity to offer free recharging as an incentive to attract customers.

"Australian cities are well suited to electric cars," Mr

Warren says. "Around 98 per cent of car journeys by urban drivers are within the range of existing all-electric cars entering the Australian market.

"We just have to think differently about them and stop assuming an electric car should copy conventional cars. They both have different strengths and weaknesses, but there's a lot to like about what electric cars have to offer."



Birth breakthrough wins Innovation Challenge

A breakthrough with the potential to prevent women in developing countries from dying as a result of childbirth has won Dr Michelle McIntosh of Monash University The Australian Innovation Challenge for 2013 and a total cash prize of \$30,000.

Dr McIntosh won the award for leading a team of scientists in devising a new delivery system for a form of a hormone that will reduce haemorrhage after birth – a technology she hopes will make childbirth safe the world over.

The team, based at the Monash Institute of Pharmaceutical Sciences, worked out how to produce an aerosol form of oxytocin that can be inhaled rather than injected to stop excessive bleeding.

"The current form of oxytocin needs to be given as an injection and that injection needs to be stored in a refrigerator," Dr McIntosh says. "The difficulty is in developing countries, where many women give birth at home or the healthcare facility can't keep the drug in refrigerated conditions, they will actually miss out on receiving this medication."

Dr McIntosh said her team's innovation was in producing the oxytocin as a powder that did not need to be refrigerated and which could be inhaled by the patient.

The project began in 2008 when a Botswanan student on an AusAID scholarship contacted Dr McIntosh looking for someone to take him on for a Masters degree. A group of academics from Monash subsequently arrived at the topic as something that would be of particular interest to him. The first study on humans is expected to take place next year in phase-one clinical trials.

Dr McIntosh won \$5000 for winning the Health category of the Innovation Challenge and edged out six category winners to take away a further cash prize of \$25,000, with the money to be used in the development of the hormone delivery system.

The Australian Innovation Challenge awards are designed to drive the nation's best ideas to commercialisation and are sponsored by Shell and supported by Innovation Australia, the Federal Government's leading statutory body supporting industry innovation.

Finalists included Academy President Dr Alan Finkel AM FTSE, recognised for his STILE digital workbook cloud-based education platform, and Professor Ming Gu FAA FTSE, for his ultra-high-capacity Petabyte Optical Storage Arrays for Big Data centres.

GLOBAL PATENT SYSTEM UNDER THE LENS

Global social enterprise Cambia and the Queensland University of Technology (QUT) are using a US\$1.6 million Bill & Melinda Gates Foundation grant to develop The Lens – an open, public web facility containing comprehensive patent information for inventions from almost 100 million documents in 90 countries, linked to millions of scientific and scholarly articles, in a form that will allow users to collect, annotate, share and embed their findings.

The global and growing resource is free to all, claimed to save innovators, institutions, investors and companies millions in lawyers' fees and make the world of patents, science and technology vastly more accessible.

It also claims to provide new measures of social and economic impact of public funding of science, and helps create pathways to choose partners, make better decisions and deliver value from that science.

Cambia (which means 'change') is an independent, non-profit institute creating new technologies, tools and paradigms to promote change and enable innovation.

"Right now, navigating global patents to make new products is like building a jigsaw puzzle in the dark," Cambia founder and The Lens Director Richard Jefferson said recently at the Canberra launch of The Lens, replacing the older Patent Lens.

"But, humankind faces unprecedented problems requiring unprecedented solutions – decentralised innovation by new and different people and institutions."

Building on the success of Cambia's popular Patent Lens, the work has attracted funding from and collaborations with some of the world's most prominent philanthropies and institutions over the years, including The Rockefeller Foundation, National ICT Australia, the US National Institutes of Health, the Lemelson Foundation, the US Patent and Trademark Office and global IT company Qualcomm, as well as two previous grants from the Gates Foundation.

The Lens' goal is simple but ambitious: "To democratise innovation by freely sharing the knowledge that has until now been locked inside a massive, fragmented, opaque global patent and innovation system that only multinational companies had the money to navigate."

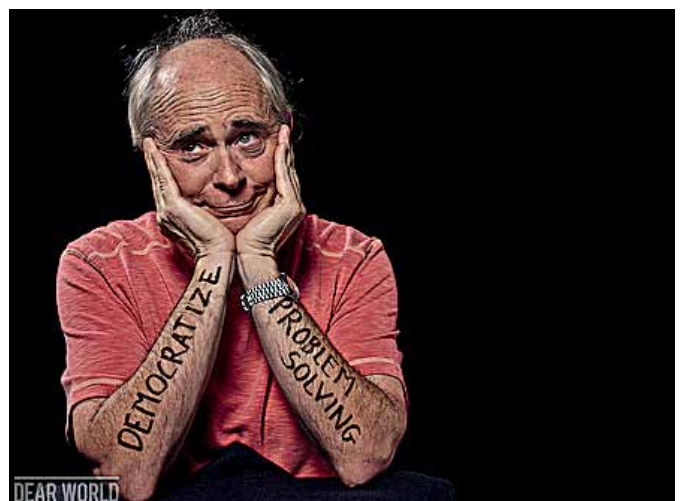
Professor Jefferson, who holds appointments in QUT's Science and Engineering Faculty and Law Faculty, said The Lens would prove a game changer for individuals, small and medium enterprises, public sector organisations and policy makers and enabled patent offices to improve their search capabilities and large companies to reduce their costs and decrease their vulnerability to so-called patent trolls.

"The partnership with QUT has been critical," he said. "This university is committed not just to studying social change and training others to drive it; QUT is itself making change happen by working with Cambia to give the public the tools to forge their own routes to affordable, relevant and successful problem solving."

"Right now, navigating global patents to make new products is like building a jigsaw puzzle in the dark."

– Richard Jefferson

Richard Jefferson is an American-born molecular biologist, named in 2003 by Scientific American as one of the 50 most influential technologists in the world, and is acclaimed as a global leader social entrepreneurship. After serving with the FAO he founded Cambia in 1991 and moved in to Australia in 2009 when he joined QUT.



Richard Jefferson

PHOTO: ROBERT X FOGARTY



PHOTO: ROBERT KERTON

Change and choice in electricity future

A new report from the Future Grid Forum, *Change and choice: The Future Grid Forum's analysis of Australia's potential electricity pathways to 2050*, looks at a range of opportunities and presents four scenarios, not predictions, through which we can view potential futures for our national electricity system.

Recent declining demand, higher electricity prices and strong adoption of rooftop solar panels have changed the energy industry's view of what is plausible in the future and trained a focus on affordability challenges, says CSIRO Energy Flagship Chief Economist Paul Graham.

Commenting on the new report, he says all the choices in its scenarios had consequences for the price of electricity, which has significantly impacted consumers in recent years.

"Electricity will not get cheaper in the coming decades, but bills can be reduced through the adoption of energy efficiency, peak demand management and on-site generation," Mr Graham says.

He says electricity has not traditionally been a service with which consumers have proactively engaged, but the Forum's scenarios present a number of ways for people to take greater control of how they consume and produce electricity.

"This proactive shift could potentially influence the business model for the electricity sector, encouraging the emergence of new services to supply an individually tailored product – not dissimilar to the telecommunications industry shift from a one-size-fits-all landline telephone system to a wide variety of mobile and associated data and entertainment services.

"One of the Forum's scenarios looks at the option for around a third of consumers to disconnect from the electricity grid through the use of on-site generation using technologies like rooftop solar panels and battery storage; and this is projected to be economically viable from around 2030 to 2040.

"Under the full range of scenarios Australia could see on-site generation grow from the current figure of eight per cent to reach between 18 and 45 per cent of total generation by 2050, but mostly while staying connected and using the grid as an electricity trading platform."

The Forum also projects that technology will allow more sophisticated ways of managing household demand during peak times with the introduction of devices such as smart air conditioners and in-home storage systems. "Better strategies for peak demand management could save two cents per kilowatt hour or \$1.4 billion per annum on distribution costs for households."

Future Grid Forum explores alternatives for Australia's energy future.

The Forum findings are a starting point from which all stakeholders can begin to understand, manage and benefit from changes to the electricity system.

"This is an extraordinary time of change for Australia's electricity industry and the Forum partners see the release of this report as an opportunity to begin a national conversation to decide the right answers for the sector, its stakeholders and, most importantly, all Australians," Mr Graham says.

FUTURE GRID FORUM

CSIRO convened the Future Grid Forum to develop and explore potential scenarios for Australia's energy future and support the decision-making process around what comes next. The Forum brought together more than 120 representatives from the electricity industry, government and community to inform and inspire a national conversation about the future of electricity in Australia and provide a way forward for the sector.

BRIDGING AUSTRALIA'S BROADBAND GAP

Despite living in the 'Digital Age', Australia is currently not prepared to fully take advantage of the services afforded by next generation broadband according to a new research report, developed by the Australian Centre for Broadband Innovation (ACBI) and CSIRO's Digital Productivity and Services Flagship.

The broadband impact and challenges report – *Bridging the Broadband Gap* – provides fresh insights and evidence to better understand the impact and opportunities offered by next generation broadband as well as advice on the necessary steps needed to mitigate the associated risks.

The report was compiled out of key findings from comprehensive community surveys, interviews with businesses and thought leaders as well as detailed analyses of existing data sources and peer-reviewed economic and social research.

"Although we are living in an increasingly digital age full of smart devices, tele-working and social networks, one in five Australian adults still do not use the internet," says Mr Colin Griffith, Director of the Australian Centre for Broadband Innovation.

"Recognising that more and more government and business services are delivered online, a key focus of our research is to understand the behaviour and capabilities of adoption and use of next generation broadband. Across the board we have found that giving more people and businesses the skills and confidence to use these broadband services effectively, will not only have a positive impact on their quality of life and business success, but also create broader economic benefits."

The findings from a number of interviews with industry and government stakeholders within the report found that a lack of certainty about the future rollout of Australia's national broadband infrastructure was a significant barrier in helping them prepare for the future.

"Like other major Australian infrastructure projects such as the Snowy River Mountain Scheme and the Sydney Harbour Bridge Harbour Bridge, the debate around our national broadband infrastructure has predominately focused on cost and scale," Mr Griffith says.

"While these are important discussions, our research highlighted that government, industry and the community need to invest in capability building through training and investment programs if we are to fully realise the benefits of next generation broadband."



Holly looks 'chooffed' about her new shoes.

Horsethotics target foot disease and lameness

The 3D printed horseshoe saga has taken a new step, with equine veterinarians and CSIRO scientists finding a new approach for a 10-year-old Melbourne mare, Holly, who suffers from a chronic hoof disease.

She is wearing 3D printed titanium shoes that were custom designed to fit her hoof and which may be the key to stomping out foot disease and lameness in horses.

The team of 3D printing experts from CSIRO worked with horse podiatrists to scan Holly's hoof and design the 'horsethotic', which aims to support the hoof and encourage it to heal, while making Holly comfortable.

Holly has spent three years suffering from a debilitating disease called laminitis, which affects the attachment between the hoof and bone, causing pain and inflammation.

Horse vet and farrier, Dr Luke Wells-Smith from the Equine Podiatry and Lameness Centre, said his team saw the 3D-printed shoe CSIRO built for a race horse (see *Focus* 181) and started to think about using 3D printing to rehabilitate lame horses.

"The new shoes will work to redistribute weight away from the painful areas of the laminitic foot and give Holly, and horses like her, the chance to recover," Dr Wells-Smith says.

CSIRO's 3D printing expert John Barnes says scanning the hoof allows them to manufacture a shoe that is the 'perfect fit' for these complicated hoof diseases, giving the horse the best possible chance for rehabilitation.

"We know that 3D printing has the potential to create so many advanced biomedical products, but rehabilitation of horses has been a completely new area of work for CSIRO," Mr Barnes says.

CALL FOR WOODEN CAR COMPONENTS

The Australian Forest Products Association (AFPA) wants more wood products used in vehicle manufacture. AFPA has been calling for a national focus on the innovative possibilities available through strategic investment in forest and forest product industries.

"Globally, our competitors have been investing in this area and are creating new growth markets – including in automotive parts manufacture," AFPA says.

"In Canada and the USA for example they have discovered that dealing with wood at a cellular level enables the creation of a whole new suite of materials which are able to be moulded into everything from

dashboards to car centre consoles.

"In short, anything which is currently made from plastic can be created from a renewable, sustainable timber resource.

"In a carbon-constrained global economy, when sustainability is a must for major manufacturers, and considering that one-third of a car's components are found inside the vehicle, it is not surprising that global car-makers are moving rapidly to trial replacement parts for their vehicles manufactured from the raw material of wood."

AFPA says a recent US Government report found that more than 200 vehicle parts could be made from wood-based cellulose, including the dashboard, centre console, brake components, heaters, seatbelts, bumper-bars, steering wheel and grill.

INCAT BUILDS FERRY FOR JAPAN

Tasmania shipbuilder Incat has signed a contract with Japanese ferry operator Sado Kisen to deliver in 2015 an 85-metre wave-piercing catamaran to operate on the 39-nautical mile route from Naoetsu Port in the Niigata prefecture to Ogi, the southernmost port of Sado Island.

The vessel will transport 700 passengers to Sado Island and has capacity for seven large trucks and 98 cars or, in car-only configuration, 173 cars.

Sado Kisen has a fleet of conventional car ferries and jet foils, however with an operating speed of 30 to 34 knots (55 to 63 kilometres per hour) the new Incat Hull 068 will be Sado Kisen's first high-speed vehicle and passenger ferry.

The Incat ferry will operate a year-round service replacing the 1995 conventional 120-metre car ferry *Kogane Maru*.

Incat will expand its production team, including taking on new apprentices, in 2014 as the shipyard is also currently building a 70-metre fast crewboat for delivery to the oil and gas industry in Azerbaijan in late 2014.

GUM TREES AT RISK

Many of Australia's eucalypt ecosystems could change beyond recognition due to increased climate stress, according to the National Environmental Research Program (NERP).

NERP's Environmental Decisions Hub has found that the heat waves, droughts and floods expected under climate change will alter environmental conditions so much that many eucalypts will no longer survive in their native ranges and replanting is unlikely to help woodlands and forests persist.

"Trees are vulnerable to climate change," says lead author Dr Nathalie Butt of the NERP Hub and The University of Queensland.

"This is due to their long regeneration times and the relatively short dispersal distances of their seeds. Many of Australia's approximately 750 eucalypt species may not be able to keep up with climate change sufficiently to avoid heavy losses – and these will, in turn, have cascading impacts on local wildlife and other plants."

Dr Butt says that modelling predicts that climate changes will drive large shifts in the trees' distribution, and large areas of central Australia will become unsustainable for eucalypts, due to extensive summer drying and more frequent droughts.

"Trees may gradually shift their ranges towards the coasts where growing conditions are more favourable, or die out due to drought.



Matthew Garratt receives the fellowship from Governor-General Quentin Bryce.

Spitfire Fellowship for robotics engineer

With support from World War II Spitfire pilots, University of NSW Canberra researchers are developing an advanced guidance system enabling micro air vehicles (MAVs) to autonomously navigate obstacles in cluttered environments, such as urban conflict zones.

Dr Matthew Garratt, from the School of Engineering and Information Technology, has been awarded the 2014 Spitfire Memorial Defence Fellowship to lead the project, which builds on his work around robotic vision and unmanned aircraft development.

The result of Dr Garratt's project, funded by the Australian Spitfire Association, will be the demonstration of a new guidance system for small, unmanned aircraft – about 15 centimetres wide or smaller – that uses low-cost cameras coupled with a small 3D ranging sensor.

New algorithms and hardware will improve the 'vision' of MAVs so they can explore complex environments and automatically avoid obstacles.

MAVs, which are largely inspired by the flight of insects and birds, are coveted by military and security organisations for their portability and stealth, Dr Garratt says.

"The applications in cluttered environments include surveillance inside buildings, search and rescue, hostage situation monitoring, chemical agent detection and bomb searches."

Many current MAVs are flown via remote control, but when they get too far from the operator video signals often drop out, rendering them ineffective. If the MAVs are flying indoors, or in urban or wooded environments, they can't rely on GPS waypoints, which are used to guide larger unmanned aircraft.

The solution is autonomous flight, and with the advent of sophisticated 'time-of-flight' (TOF) cameras, which provide range for every pixel of an image, there are new opportunities to realise this autonomy.

TOF cameras about the size of a matchbox – or small enough to mount on an MAV – have only been released in the past 12 months, and the use of these cameras for obstacle avoidance in robotics "has not yet been properly exploited", Dr Garratt says.

BEES WEAR SENSORS TO HELP FARMERS

Thousands of honey bees in Australia are being fitted with tiny sensors as part of a world-first research program to monitor the insects and their

environment using a technique known as 'swarm sensing'.

The research is being led by CSIRO and aims to improve bee pollination and productivity on farms as well as help understand the drivers of bee Colony Collapse Disorder (CCD), a condition decimating honey bee populations worldwide.

Up to 5000 sensors, measuring 2.5 x 2.5 millimetres are being fitted to the backs of the bees in Tasmania – the first time such large numbers of insects have been used for environmental monitoring.

"Honey bees play a vital role in the landscape through a free pollination service for agriculture, which various crops rely on to increase yields. A recent CSIRO study showed bee pollination in faba beans can lead to a productivity increase of 17 per cent," CSIRO science leader Dr Paulo de Souza, who leads the swarm sensing project, says.

"Around one-third of the food we eat relies on pollination, but honey bee populations around the world are crashing because of the dreaded varroa mite and CCD. Thankfully, Australia is currently free from both of those threats."

The sensors are tiny radio frequency identification sensors that work in a similar way to a vehicle's e-tag, recording when the insect passes a particular checkpoint. The information is then sent remotely to a central location where researchers can use the signals from the 5000 sensors to build a comprehensive three dimensional model and visualise how these insects move through the landscape.

To attach the sensors, the bees are refrigerated for a short period, putting them into a rest state long enough for the sensors to be secured to their backs with an adhesive. After a few minutes, the bees awaken and are ready to return to their hive and start gathering valuable information.

The next stage of the project is to reduce the sensors to 1mm so they can be attached to smaller insects such as mosquitoes and fruit flies.



A bee fitted with the sensor.

300,000 CAMELS STILL ROAM THE BUSH

Australia still has a feral camel population of about 300,000, following the removal of more than 160,000 over the past four years under the Australian Feral Camel Management Project (AFCMP), conducted by Ninti One.

Ninti One Managing Director Jan Ferguson says the \$19 million program has reduced feral camel densities around the 18 environmental sites targeted, especially the in Simpson Desert and Pilbara regions.

When roaming in unmanaged numbers feral camels threaten vegetation, wildlife and Aboriginal cultural assets, damage community and pastoralism infrastructure and become a risk to human safety.

The camel removal and population estimates were part of a four-year survey and management activity across remote Australia designed to reduce camel impacts at 18 known biodiversity sites and the impacts of camels in pastoral areas, and increase information on the feral camel population.

Ninti One is an Alice Springs-based not-for-profit company that manages the research activities and partnerships of the CRC for Remote Economic Participation, the IP from the former Desert Knowledge CRC and the AFCMP.

Iron ore shiploading facility at Port Hedland.



PHOTO: ISTOCKPHOTO.COM

Survey says mining 'broadly accepted'

Mining is broadly accepted in Australia but people trust non-government organisations more than the mining industry, or Federal or State governments, according to preliminary findings of a landmark national survey conducted and funded by CSIRO.

Participants in the survey believe that mining saved the nation in the Global Financial Crisis, contributes significantly to the economy and standard of living, and creates jobs. They also think the nation, but not their community, is dependent on mining and agree strongly with restrictions on foreign ownership of Australian mining operations.

The survey participants, from 11 mining regions as well as non-mining and metropolitan areas, recorded similar levels of acceptance of mining. This finding was based on a question asking the 2531 participants to what extent they accepted mining – 91.5 per cent at least somewhat accepted mining, and slightly more than half were more positive.

The first part of the survey, undertaken in August/September 2013, found that this acceptance depended at least partly on a need to gain local community consent before mining development took place.

The survey will also be undertaken in China and Chile to provide a basis for regional, national and international comparisons of community attitudes.

The survey includes statements about key perceived impacts and benefits of mining, which participants rated on a scale of 1 (strongly disagree) to 7 (strongly agree).

The highest rated benefit was mining's positive effects on Indigenous and non-Indigenous communities (including employment and training opportunities), with a score of 5.07. This response was consistent across mining, non-mining and metropolitan areas.

Participants agreed that mining had helped to develop infrastructure (social, roads and ports, communications and information technology) in regional Australia, with an overall rating of 4.61. People in metropolitan areas felt this benefit was stronger than those in mining and non-mining areas.

The findings were not emphatic about the economic benefits of mining. Participants were asked to rate the extent to which the average Australian, their family and themselves were financially better off because of mining. Overall, participants 'somewhat agreed' (3.62) that they were better off, with those in metropolitan areas most in agreement (3.70).

The main negative impact of mining was perceived to be on the environment (including climate and water), with a score of 4.62. This response was consistent across mining, non-mining and metropolitan areas.

Participants disagreed that mining impacts negatively on the cost of living, including housing. The mean response was 3.17, with stronger disagreement in mining regions than metropolitan or non-mining areas.

Community trust in the mining industry, government and non-government organisations was also surveyed. On a scale of 1 (not at all) to 5 (very much so), participants were asked the extent to which they trusted the industry, State government, Federal government and NGOs to 'act in the best interests of society', 'act responsibly' and 'do what is right'.

Overall, trust in the industry, governments and NGOs was around or below the midpoint of the scale, with NGOs the most trusted sector across the mining, non-mining and metropolitan areas.

The survey of 5000 Australians was carried out in two waves: before and after the Federal election. The second half of the survey was undertaken in November 2013, with a full set of results expected in early 2014.

FINDING THE RIGHT WATER BALANCE



Meeting the challenge of maintaining optimal mine water storage.

The coal mining industry may soon be better equipped to manage water and deal with extreme weather events, thanks to a new model developed by CSIRO and unveiled at the 20th International Congress on Modelling and Simulation in Adelaide.

The model aims to forecast future mine water needs and help the industry address the challenges of both excessive and insufficient water on mine sites. The research was conducted in Queensland's Bowen Basin, home to Australia's largest coal reserves, which has one of the world's most variable climates.

Professor Damian Barrett, head of CSIRO's Water in the Resources Sector research, said a key industry challenge was to maintain mine water storage at an optimal level to ensure water security for operations during drought but also to eliminate unregulated discharges during flood periods.

The model is depicted through three perspectives: the business perspective, capturing the mine operation practices within a mine or across several mines or companies; the environmental perspective, representing all the climate change patterns such as rainfall and catchment histories and weather forecast data; and the decision perspective, which considers trade-offs by demonstrating how to develop strategies to best meet business needs while considering environmental constraints and opportunities.

"This methodology provides a rigorous and objective technique for developing management strategies and assessing risk," Professor Barrett said.

The model was developed as part of a suite of broader CSIRO research on Bowen Basin coal mines through its Water for a Healthy Country Flagship. Research in the region is providing strategies to help the industry forecast mine water quantity and quality, improve water use efficiency onsite and improve understanding of the impacts of mine water use on regional water.

Mining changing the way it approaches water

The past eight to 10 years has seen an evolution in the way in which the mining sector approaches water, according to NWC Chair Hon Karlene Maywald FTSE, Chair of the National Water commission (NWC).

She told the recent Water in Mining Conference in Brisbane that this has come about for a number of reasons:

- a growing population was seeing demand for Australian minerals, metals and energy increase, leading to increased pressure on water as a critical business imperative and an asset that must be managed accordingly;
- the mining sector had become more conscious of the full value of water – not only the cost of supply, but all the costs associated with collection and storage, infrastructure, water treatment, monitoring and disposal; and
- it also encompassed the business, environmental and social imperatives of protecting water quality, sustaining ecosystems and maintaining cultural values.

"Water plays a crucial role in every stage of the life cycle of mineral and petroleum operations," she said.



Karlene Maywald addressing the launch of the ATSE Report *Drinking Water through Recycling* in Melbourne in October 2013.

"It is not just needed in the mining and extractive processes. It is also needed in the exploration and refining stages.

"It helps produce power, cool equipment, manage waste, suppress dust and it is used for washing, right down to flushing toilets on site.

"No water means no business."

She highlighted the value of water to mining, noting a 2004-05 Australian Bureau of Statistics calculation that put an average value-added figure

per megalitre of water used at around \$86,000 for coalmining, \$50,000 for metal mining and \$25,000 for other mining. More recent work published by the CSIRO in 2008-09 showed mining produced more value per gigalitre of water used than manufacturing or irrigation, she said.

Water management in resources was increasingly intersecting with other sectors – frequently multiple interest groups from government, non-government, communities and other industry sectors – which involved risk management, with growing external scrutiny.

For example, financial analysts were rating companies according to their exposure to, and management of, water risk as a direct threat to production.

These factors had influenced a maturing approach to water management, set against an overarching backdrop of significant water reform over the past decade in Australia. Mining companies had needed to look at their operations not just through a business lens or a local lens, but through a national lens.

CAVES HOLD CLUES TO 'BURIED TREASURE'

Australia's limestone caves hold precious clues to Australia's groundwater – the nation's most important savings bank of fresh water – a leading water scientist says.

As the nation comes to rely increasingly on groundwater to sustain its cities, mining and agriculture, it will be crucial to find out how its aquifers get refilled in order to avoid over-extraction, says Professor Andy Baker of the National Centre for Groundwater Research and Training (NCGRT) and The University of New South Wales (UNSW).

"We're facing a global water crisis, and we need to know if we're using our groundwater sustainably, and correctly predict the recharge rates of our aquifers," Professor Baker says. "Observing water movement in caves is a cheap and reliable way to do this."

Professor Baker and his team have been using caves as 'underground rain gauges' to measure the amount of water passing through them.

"The great thing about caves is you can just walk into them and observe how the water infiltrates into the ground," he says. "And some caves can be found leading down to an aquifer, and you can directly see the water table. It's like standing in a house with a leaky roof. As the water drips and travels through the cave, we can measure where it comes in, how much comes in, and where it goes."

In an ongoing study, the NCGRT researchers have installed the world's largest collection of drip-water measuring devices in Wellington Caves, NSW. The scientists can then compare these results with recharge estimates created by mathematical models to test the mathematical predictions.

Professor Baker says the study shows that as water travels through the ground, a lot more of it was lost than expected.

"We created an artificial rainfall in one area and only one per cent of the water ended up in the cave. We don't know where the rest went – it could have evaporated, flowed somewhere else, or been taken up and transpired by trees and plants.

"This is why observing water movement in caves is useful – it gives you a realistic measurement of what the aquifer might receive, because the groundwater is only 'locked up' when it reaches the water table."



Drip water reaching the groundwater, Cathedral Cave, Wellington, NSW.

Water may come from below the sea.



PHOTO: ISTOCKPHOTO.COM

Freshwater sources under the sea

Scientists have discovered huge reserves of freshwater kilometres out to the sea, providing new opportunities to stave off a looming global water crisis.

A new study, published in the international scientific journal *Nature*, reveals that an estimated half a million cubic kilometres of low-salinity water is buried beneath the seabed on continental shelves around the world.

The water, which could perhaps be used to eke out supplies to the world's burgeoning coastal cities, has been located off Australia, China, North America and South Africa.

"The volume of this water resource is a hundred times greater than the amount we've extracted from the Earth's sub-surface in the past century since 1900," says lead author Dr Vincent Post of the National Centre for Groundwater Research and Training (NCGRT) and the School of the Environment at Flinders University. "Knowing about these reserves is great news because this volume of water could sustain some regions for decades."

Dr Post says that groundwater scientists knew of freshwater under the seafloor, but thought it only occurred under rare and special conditions. "Our research shows that fresh and brackish aquifers below the seabed are actually quite a common phenomenon."

These reserves were formed over the past hundreds of thousands of years when on average the sea level was much lower than it is today, and when the coastline was further out, Dr Post explains. "So when it rained, the water would infiltrate into the ground and fill up the water table in areas that are nowadays under the sea.

"It happened all around the world, and when the sea level rose when ice caps started melting some 20,000 years ago, these areas were covered by the ocean. Many aquifers were – and are still – protected from seawater by layers of clay and sediment that sit on top of them."

The aquifers are similar to the ones below land, which much of the world relies on for drinking water, and their salinity is low enough for them to be turned into potable water, Dr Post says.

MINING AND DINING BOOMS DEPEND ON WATER

The next mining boom and the emerging 'dining boom' in agriculture will depend critically on whether Australia has enough water to support them.

With surface supplies becoming scarce, our future economic prospects are likely to rely increasingly on our underground 'water bank', says Professor Craig Simmons, Director of the National Centre for Groundwater Research and Training (NCGRT).

"Currently, \$34 billion worth of Australian industry per annum is dependent on groundwater and the direct value of groundwater to the national economy is about \$7 billion a year, according to a new report that the Centre has commissioned from Deloitte Access Economics," he says.

"However, with Australia now starting to outgrow its surface resources and the prospect of erratic rain fall under climate change projections, it is clear we will rely increasingly on groundwater to support large scale food, mineral and energy production into the future," he says.

The study found that Australia uses about 3500 gigalitres (GL, or billion litres) a year of groundwater, from an estimated sustainable reserve of 29,173 GL. About 6500 GL is held in entitlements to extract groundwater.

Agriculture and grazing are the biggest users, accounting for 60 to 70 per cent of total use, followed by mining and manufacturing with around 20 to 30 per cent and cities with 10 per cent. Groundwater also provides major services to the Australian landscape, in the form of water for trees, vegetation and wetlands, as well as providing 'base flow' into rivers and lakes, where it is widely used for recreation and in drinking supplies.

The Deloitte Access Economics study suggests that the value of Australian groundwater is likely to increase as surface supplies become scarcer during times of drought and under changing climates. It thus provides a valuable 'buffer' in times of shortages.

"It is not generally appreciated, but mining and energy production involve a lot of water – either for dewatering mines and bores, for moving minerals as slurries, for extracting minerals using hydrometallurgy, for suppressing dust, washing equipment, restoring landscapes and so on," Professor Simmons says. "So any future mineral booms will depend critically on how well we manage our groundwater.

"Likewise, the much-talked of 'dining boom' – the expansion in worldwide agriculture driven by global food insecurity – will also depend critically on water, especially for irrigation. Given the scarcity of Australia's surface supplies, more of this water will come from underground in future."

Professor Simmons cautions that Australia still lacks a detailed knowledge of the exact size of its groundwater resources and how rapidly they are renewed. Without knowing this essential information, there is always a danger we will over-exploit it, causing supplies to run out – as is happening elsewhere around the world.

"If we look after our groundwater, Australia can not only enjoy future mining and dining booms, but also provide for healthy landscapes and environments and thriving cities and towns."

ENVIRONMENTAL WATER TRADING BACKED

The decision by the Australian Government, through the Commonwealth Environmental Water Holder entity, to trade environmental water on the temporary market, has been acclaimed by water authorities.

National Water Commission Chair, Ms Karlene Maywald FTSE said the move to more actively manage environmental water holdings would help deliver the best possible environmental and economic outcomes.

"It is in keeping with National Water Initiative principles that envisaged 'the ability for environmental water managers to trade water on temporary markets at times when water is not required to contribute towards environmental and other public benefit outcomes,'" she said.

Murray-Darling Basin Authority chairman Mr Craig Knowles also welcomed the news. "Far from this being a retrograde step for the environment, temporary trade means that water for the environment can be fully valued and take its place for the first time in Australia's history alongside other classes of water."

Look after groundwater or face scarcities

Governments around the world need to get behind the UNESCO plan to develop a Global Framework for Action on groundwater governance, due for release shortly, says Professor Craig Simmons, Director of Australia's National Centre for Groundwater Research and Training (NGCRT).

He urges the world to take better care of its groundwater resources – or risk dangerous scarcities, economic impacts and potential conflicts in coming decades.

"Groundwater governance may sound like a dry argument to some people – but it's a life-and-death issue for millions. It also affects the ability of countries like China and India to continue to grow their economies and to feed three billion people. And, since water scarcity is sometimes a trigger for conflict, it also holds the key to a more peaceful world.

"A significant part of the world's food supply depends on groundwater – which is already starting to run short in critical regions such as the western US, Mexico, north-western Sahara, Indus Basin and North China Plain," Professor Simmons says. "This is something every consumer should be concerned about, as it affects global food prices."

Professor Simmons says that groundwater supplies around 30 per cent of all the fresh water used in Asia – and if it runs short, could threaten food security, economic growth and many huge cities.

Australia has a great deal to contribute towards improving the world's groundwater governance, he says.

Groundwater makes up 97 per cent of the world's available fresh water. Total global use is estimated by scientists at around 1000 cubic kilometres a year, with the largest users being India, China and the US. Since 1900, the world has drawn down its groundwater reserves by an estimated 4500 cubic kilometres – and demand continues to increase, especially in arid countries, which are rapidly running short of water that can be affordably extracted.

"In the Great Artesian basin we have demonstrated one of the rare cases of conserving and improving water resources in a massive groundwater basin by capping uncapped free-flowing bores to restore water pressure in the basin and protect the health of important groundwater-dependent ecosystems and springs.

"Similarly, in the Murray–Darling Basin we have established one of the world's most effective water management systems for a large river basin – where one of the big issues is managing water across different boundaries and jurisdictions.

"And we have demonstrated the practicality of managed aquifer recharge – or water banking – to replenish groundwater during wet times.

The NCGRT is an Australian Government initiative, supported by the Australian Research Council and the National Water Commission.

44 MILLION STARS AND COUNTING

Tens of millions of stars and galaxies, among them hundreds of thousands that are unexpectedly fading or brightening, have been catalogued properly for the first time by Professor Bryan Gaensler, Director of the ARC Centre of Excellence for All-sky Astrophysics (CAASTRO) at the University of Sydney, and Dr Greg Madsen, from the University of Cambridge.

They undertook this formidable challenge by combining photographic and digital data from two major astronomical surveys of the sky, separated by 60 years, producing one of the most comprehensive and accurate compilations of stars and galaxies ever produced, covering 35 per cent of the sky and using data going back as far as 1949.

Professor Gaensler and Dr Madsen began by re-examining a collection of 7400 old photographic plates, which had previously been combined by the US Naval Observatory into a catalogue of more than one billion stars and galaxies.

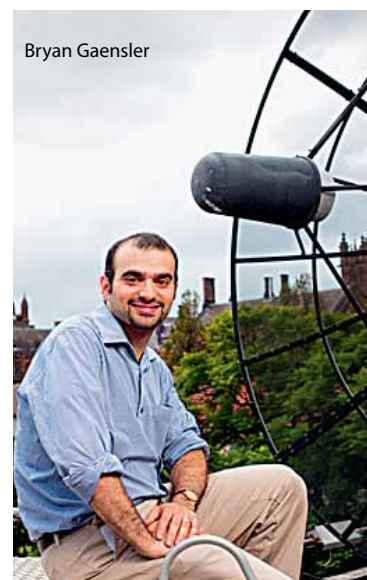
The astronomers then set out to painstakingly match all the objects in this catalogue with more modern measurements from the Sloan Digital Sky Survey. Using very stringent criteria to be absolutely sure of a match, Professor Gaensler and Dr Madsen produced a final catalogue of 44 million stars and galaxies that had definitely been seen twice: both in old photographs and with modern cameras.

"Thanks to clever computer algorithms, we thankfully didn't need to inspect all billion stars and galaxies individually," Professor Gaensler says. "But even so, processing the data and then testing everything to make sure we got it right took us more than a year.

"This cosmic game of Snap provides two important breakthroughs.

First, it gives far more accurate measurements of the brightness of each individual star than had ever previously been possible. Second, by comparing two photographs of each star taken up to 60 years apart, it becomes easy to identify stars whose brightness has slowly changed."

The researchers found that approximately 250,000 objects in their new catalogue, or about 0.6 per cent of all the stars in the sky, change in their brightness by quite large amounts over a human lifetime.



Bryan Gaensler

FIND BLACK HOLES ON THE BUS

Radio Galaxy Zoo, launched in December, is a new 'citizen science' project that lets anyone become a cosmic explorer who can discover black holes on the ride to work or hunt them down on a home computer.

By matching galaxy images with radio images from CSIRO's Australia Telescope, people can work out if a galaxy has a supermassive black hole.

"It takes about a minute to learn what to do," says CSIRO's Dr Julie Banfield, an Australian coordinator of the international project. "Then to actually work with the images takes only a few seconds each – perhaps a couple of minutes for the really tough ones.

"You just need match up a couple of pictures and look for what you think is the galaxy at their centre."

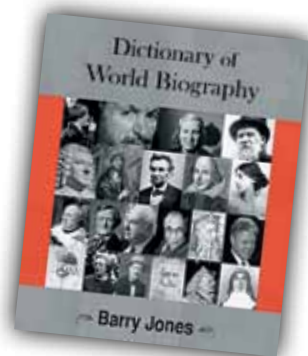
Those who join up become part of a community of almost a million people who work in the 'Zooniverse' – a set of citizen-science projects covering everything from galaxy shapes to cancer data and whale songs.

Radio Galaxy Zoo is online at <http://radio.galaxyzoo.org/>.

The world's greats – according to Barry Jones

By Ian Rae

ianrae@bigpond.com



Dictionary of World Biography, by Barry Jones (ANU, Canberra, 2013) is available free as an e-Book or pdf (word-searchable) or, for \$50, as a print-on-demand hardback (press.anu.edu.au/titles/anu-lives-series-in-biography/dictionary-of-world-biography/).

I have a number of biographical dictionaries on my shelves, but nothing matches the extent or the style of Barry Jones's *Dictionary of World Biography*.

My home resources are augmented by massive collections (in the university library) like the *Oxford Dictionary of National Biography* and specialist publications like the *Dictionary of Scientific Biography* and *The New Grove Dictionary of Music and Musicians*.

I must say at the outset, however, that I don't use the hard copies very much these days, since the internet is at hand when I'm working at my desk. The *Australian Dictionary of Biography* is accessible online, but with no bibliographic data so I still use my hard copies occasionally.

Why, then, would anybody publish a work like this and why would anyone wish to own a copy? I think the answer to the first question is contained in the introduction, where Jones takes us through the history of his dictionary, starting in the 1950s, traversing his trials with Penguin and a series of abbreviated, shared-authorship versions published by Macmillan and others in the 1980s, until he reaches the promised land in the 1990s with Information Australia and *The Age*. The story was told in *A Thinking Reed* (2006) but its repetition in 2013 shows that the pain lingers. With the present compilation, under the auspices of ANU's National Centre of Biography, he gets it off his chest again and welcomes the opportunity to 'rethink and rewrite'.

The second is a harder question. Maybe you like books and eschew the internet, or maybe you like to have both. I do, so

I'm pleased that this one is something of a hybrid because the electronic versions can be searched by word. With more than 900 pages and (I estimate) more than 8000 entries, Jones's *Dictionary* has better coverage than any single volume I have seen. Nonetheless, my local library said it no longer purchases books like this for its (ever-diminishing) reference section.

A compiler faces thousands of decisions, at the individual level – who's in and who's out – but also at the national level. Jones notes that he "was careful about the relative balance of entries" and "wanted to avoid either including too many Australian entries, or overreacting and having too few". Keeping up to date is another overarching problem, too, so I sampled a few cases. Obama, Cameron and Merkel have been added, along with Abbott, Gillard, Rudd and Turnbull.

Apart from the coverage, I would draw attention to three reasons for consulting this single, indeed singular, volume.

First, about half of the entries include a reference for further reading, and as an anti-Latinist I am pleased to see that cross-references are denoted by asterisks rather than 'q.v.'.

Second, Jones is more forthright in expressing his opinions than are most compilers, so there are some pithy comments (original and reported). Margaret Thatcher, for example, is described as having "a conviction of infallibility"; Douglas MacArthur's "mastery of the military art place him among history's greatest commanders"; William Somerset Maugham's publications can contain "thinly veiled portraits (not always kind

of literary friends"; and there was Friedrich Hölderlin who "fell in love with Greek mythology and his employer's wife".

Third, and most fun, is the opportunity to compare your judgment of who's in and who's out. Australian politicians of any note are all there, along with Bradman (but not many other sporting figures). Continuing the national pantheon, there are medical scientists like Howard Florey, John Eccles, Ian Frazer and Peter Doherty, chemist John Cornforth (who died recently) and among the physicists, Braggs. From the Arts, you'll find Errol Flynn, Robert Helpmann, Patrick White, Henry Lawson and Banjo Paterson, as expected, but would you have expected Cate Blanchett? Daniel Mannix is there and so is George Pell.

Internationally, in disciplines close to the heart of an Academy of Technological Sciences and Engineering, I found the Brunels and Thomas Telford, but not the Roebblings (father and son), John Coode, C.Y. O'Connor or John Bradfield. Turing and Steve Jobs are in, but not Bill Gates and Gordon E. Moore. Aircraft men Frank Whittle, Willy Messerschmitt, Igor Sikorsky, Andrei Nikolaievich Tupolev and the Wright brothers are in. Cars: Henry Ford and 'Boss' Kettering are in, but Thomas Midgley Jr and the Dodge Brothers are not.

Most entries are short but a page or more is devoted to each of Jesus Christ, Abraham Lincoln, Henry Ford, William Shakespeare, Aleksei Nikolaievich Tolstoy, Adolf Hitler, Winston Churchill and Franklin Delano Roosevelt.

I thought that there was a bit much classical Greece, but for more modern times the international coverage is excellent, with many political and social figures from Africa and South America included.

PROFESSOR IAN RAE FTSE, an Honorary Professorial Fellow at the University of Melbourne, is a former Technical Director of ATSE. He was President of the Royal Australian Chemical Institute (2006–08) and has served for more than a decade as a technical adviser to the UN Environment Program.

The Hon Dr Barry Owen Jones AO FAA FTSE FAHA FASSA is a polymath, writer, lawyer, social activist, quiz champion and former politician. He is the only member of all four Australian Learned Academies and spent 21 years as a Member of the House of Representatives for Lalor, including substantial Ministry service (Minister for Science 1983–90, Minister for Customs 1988–90), following more than five years in the Victorian Parliament. He followed Dr Jim Cairns as Member for Lalor and was followed by Ms Julia Gillard and was twice National President of the ALP.

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Mark Randolph

Mark Randolph is WA Scientist of the Year

Winthrop Professor Mark Randolph FTSE, from The University of Western Australia's Centre for Offshore Foundation Systems, has been named WA's 2013 Scientist of the Year.

Professor Randolph is a world-leading scientist specialising in developing geotechnical solutions for the offshore oil and gas industry. He has built a world-class research group in WA, attracting industry investment and providing practical solutions to real-world problems.

Professor Randolph is a distinguished geotechnical engineer who has excelled both in academia and in solving real world issues for industry. Since the mid-1980s, he has applied his expertise to meet the scientific

and engineering challenges of WA's local offshore oil and gas industry. His contributions have ranged from analysis and design of piled foundations to solutions for offshore foundations, anchoring systems and pipelines.

His leadership has established Perth as an internationally recognised hub for excellence in geotechnical engineering, attracting many international companies to seek solutions in Perth for their geotechnical engineering problems. Much of this innovative research has been adopted by industry internationally.

Premier and Science Minister Colin Barnett made the announcement at the 2013 Western Australian Science Awards presentation evening in Perth. He said the awards celebrated the outstanding work of the state's best scientists and science communicators.

"I congratulate all winners and finalists. The projects, in fields ranging from medical research to plant biology and community outreach, are all quite extraordinary and really demonstrate the value of science to the whole community," Mr Barnett said.

Academy Fellow Professor Peter Quinn FTSE, also from UWA, was the 2012 WA Scientist of the Year. He is Professor of Astronomy and Astrophysics at UWA and Director of the International Centre for Radio Astronomy Research (ICRAR) at the university.

Professor Quinn is a world leader in data-intensive science; the design, development and operation of super-science facilities; the theory of galaxy formation; and the search for dark matter.

NICTA CHIEF HEADS NSW IPC

NICTA CEO Professor Hugh Durrant-Whyte FRS FAA FTSE has been appointed to Chair the NSW Government's Innovation and Productivity Council (IPC), a high-level policy advisory group which provides guidance on priorities for innovation-led economic development and productivity.

Professor Durrant-Whyte has been a member of the IPC since 2011 and has been appointed to chair the group at least until his first three-year term expires in July 2014.

"The Council has a great opportunity

to assist government drive innovation and productivity in NSW. Collaboration, technology, attracting talent and skills, and connecting research to industry outcomes will be key to the future economy and prosperity of the state," Professor Durrant-Whyte says.

The appointment reflects the leading role NICTA is playing in the innovation ecosystem. NICTA produces the highest rate of start-up companies across publicly funded research in Australia, averaging six start-ups for each \$100 million invested.

NICTA's innovations include world-first technologies for its start-ups, such as software to dramatically improve the security of operating systems – now on more than 1.5 billion mobile devices worldwide – and technology that measures the response of nerves to stimulation in patients who are undergoing spinal implant therapy to treat chronic pain.

It is also training the ICT innovation leaders of tomorrow, producing almost one-third of Australia's information and communications technology (ICT) PhDs with its 22 partner universities across Australia.

NICTA (National ICT Australia Ltd) is Australia's Information and Communications Technology Research Centre of Excellence and develops technologies that generate economic, social and environmental benefits for Australia. It collaborates with industry on joint projects, creates new companies and provides new talent to the ICT sector through a NICTA-enhanced PhD program. With five laboratories around Australia and more than 700 people, NICTA is the largest organisation in Australia dedicated to ICT research and is funded by the Australian Government, the Australian Research Council, state governments and universities.



Hugh Durrant-Whyte

ATSE recognises contribution of country teacher

The Academy's SA Division recently recognised a country high school teacher with its 2013 Teacher Award.

SA Division President Dr Meera Verma FTSE presented Mr John Agnew with a plaque and a \$2000 cheque to use in the science department, which he will put towards data-logging technology.

"I'm looking forward to having that equipment," he said. "Hopefully it will be able to make the children's education that little bit better."

The ATSE Award is presented annually in conjunction with the SA Science and Engineering Challenge.

Mr Agnew has been a teacher for 30 years and has spent the past 10 years at Naracoorte High School, with nine years as science coordinator and five as mathematics coordinator. Naracoorte is in south-east SA, near the Victorian border.

Mr Agnew was nominated by the school's principal, Kym Grant, who acknowledged his great contributions to the school.

"I was flattered," Mr Agnew said. "I'm confident I'm doing a good job but it is nice to get the acknowledgement. I think the thing about teaching is that you put your best in but you often get lots of criticism and don't get lots of other things."

Mr Agnew makes it his priority to encourage his students to get involved with extra activities inside and outside the classroom. These include the National Youth Science Forum, which two teens are attending next year in Perth, the SA Science and Engineering Challenge, and the Science Experience, which takes place in the summer

holidays and includes a three-day tour around universities in Adelaide.

Mr Agnew said it was important for students to embrace challenges.

"I like to give them a vision of what's possible," he said. "Country communities don't have all the job options the cities do so it is good for them to see all the job prospects there are."

LYN BEAZLEY JOINS SCIENCE HALL OF FAME

Former WA Chief Scientist Professor Lyn Beazley AO FTSE has been inducted into the Western Australian Science Hall of Fame.

The WA Premier, Mr Colin Barnett, announcing the award in Perth, paying tribute to Professor Beazley's "tireless work" in the promotion of science and scientists in WA.

Professor Beazley was appointed Chief Scientist of WA in 2006 and has been a tireless national and international ambassador for science and science engagement in WA. She stepped down in December.

She undertook her undergraduate studies at Oxford University and her doctorate at Edinburgh University. Over a 30-year research career she built up an internationally renowned research team that focused on recovery from brain damage. Her research also changed clinical practice in the treatment of infants at risk from pre-term delivery.

She was awarded an Order of Australia in 2009 for service to medical science and her contribution to the development of science policy in WA.

Another Fellow, Professor Stephen Hopper AC FTSE, former Director of the Royal Botanic Gardens in Kew, London, was inducted into the WA Science Hall of Fame last year.

Professor Hopper returned to WA in October 2012 to take up a position at The University of Western Australia. Professor Hopper is an internationally acclaimed plant conservation biologist who has made an outstanding contribution to biodiversity preservation in WA. He has made significant improvements to a number of the state's conservation programs and infrastructure and was named a Companion of the Order

of Australia for his service as a global science leader.

Another Fellow, Dr Bernard Bowen AM FTSE, was inducted into the WA Science Hall of Fame in 2011.

In a long and distinguished career, Dr Bowen has made a significant contribution to fisheries research, marine resource management, environmental protection and radio astronomy in WA. He was Director of the Department of Fisheries for 23 years and has chaired many committees in the science field at state, national and international levels.

He played a significant role in the development of the WA Fisheries and Marine

Lyn Beazley



Meera Verrma makes the presentation to John Agnew.



Research Laboratories, the WA Wildlife Research Centre, the WA Marine Science Institution and the International Centre for Radio Astronomy Research.

In 1991, Dr Bowen was appointed as a Member of the Order of Australia for his services to the fishing industry.



Thomas Maschmeyer takes renewable energy award

Professor Thomas Maschmeyer FAA FTSE was honoured in the 2013 NSW Science and Engineering Awards in Sydney, winning the Renewable Energy Innovation category.

His research into the conversion of renewable resources into chemicals, pharmaceuticals and fuels, and the remediation of waste water streams, treatment of algal blooms and power station effluent, has resulted in significant scientific advances and the establishment of two companies with a combined value exceeding \$300 million and attracting interest and participation from Norske Skog, Exxon Mobil, Energy Australia, Boeing, Virgin Air and GE.

Professor Maschmeyer's research is characterised by the intimate connection between cutting-edge fundamental research and the development and commercialisation of technological solutions to some of the greatest challenges of our lives: energy supply and security; the provision of chemicals and materials to enhance our standard of living; and the mitigation of greenhouse gas emissions through the innovative exploitation of novel carbon feedstocks.

Trophies were handed out in eight categories during an awards ceremony

Thomas Maschmeyer with Marie Bashir.

at Government House, Sydney, which was attended by NSW Governor, HE Marie Bashir AC CVO FTSE, and NSW Chief Scientist and Engineer, Professor Mary O'Kane FTSE.

SUE MURPHY NAMED 2013 CIVIL ENGINEER

Ms Sue Murphy FTSE, CEO of the Western Australian Water Corporation and immediate past Chair of the Water Services Association of Australia has been named by Engineers Australia as the national Sir John Holland Civil Engineer of the Year for 2013.

This prestigious award recognises achievements in civil engineering and shines a spotlight on the profession to young people interested in pursuing an engineering career.

After winning a Clough Scholarship as an undergraduate at The University of Western Australia, Ms Murphy started a 25-year career with Clough Engineering in 1980. Twelve years in the field was followed by corporate roles with a focus on human resources, safety and engineering design management. In 1998 she was the first woman appointed to the board of Clough Engineering Ltd.

In 2004 she joined the Water Corporation of WA, with responsibility for delivery of capital projects and long and short-term planning, and in 2008 was appointed Chief Executive Officer.

In 2009, 2010, 2011 and 2012, she was listed in the Top 100 most influential engineers in Australia by Engineers Australia.

Sue will be the first to point out that the award recognises the efforts of many people with whom she has worked over the years, most recently here at the Water Corporation.

"Not only has Sue demonstrated strong leadership here with us at the Water Corporation but she has also been very active in Australian and international water industry affairs, including



Sue Murphy

in her role as the past Chair of the Water Services Association of Australia," said Water Corporation Chair Eva Skira.

"She has mentored many young engineers, particularly women, who now occupy senior roles across our industries, and has made significant contributions to community life through roles in tertiary education, commerce and industry."

MYANMAR LEADER HONOURED

Myanmar democracy leader and Nobel Peace Prize winner Daw Aung San Suu Kyi attracted a great deal of public and media interest during her visit to Australia in November.

A keynote event was her award of an Honorary Doctorate of Laws by Monash University.

Monash Chancellor and ATSE President Dr Alan Finkel AM FTSE and Vice Chancellor Professor Ed Byrne AO FTSE welcomed the Myanmar Opposition Leader to the university ahead of a glittering award ceremony.

Professor Byrne said the university was extremely proud that Daw Suu Kyi had chosen to accept its highest honour.

"Daw Aung San Suu Kyi is one of the most eminent statespersons and advocates for peace and non-violence in the world today. She is universally beloved as a great and inspiring figure and is seen as a symbol for the global struggle for human rights. Her thought has provided critical support for non-violent action for democracy and reconciliation," Professor Byrne said.

"She has a special and enduring connection with Monash University, as a patron of Global Reconciliation, an international non-government organisation based at Monash that promotes peace and reconciliation."

Alan Finkel, Aung San Suu Kyi and Ed Byrne before the ceremony.





Two Fellows win ARC grants

Professor Tanya Monro FAA FTSE and Professor Gordon Wallace FAA FTSE have been successful in winning major Australian Research Council Centre of Excellence grants for funding starting in 2014.

Professor Monro's team has won a \$23 million grant for an ARC Centre of Excellence for Nanoscale BioPhotonics at the University of Adelaide. Professor Monro is Director of the university's Institute for Photonics and Advanced Sensing (IPAS).

Professor Wallace's team from the University of Wollongong has won a \$25 million grant for a new ARC Centre of Excellence for Electromaterials Science (ACES). Professor Wallace is Director of the Intelligent Polymer Research Institute, UoW, and Director of the Australian National Fabrication Facility, Materials Node.

The Adelaide project will develop technologies to help researchers create a 'window into the body' by crossing the boundaries of biology and nanoscience and using light-based sensors to probe molecular processes within living systems.

"Our understanding of the processes of life is limited by constraints imposed by studying cells and biological systems outside the body. Much more can be learnt if we can work within," says Professor Monro, Director of the new Centre of Excellence.

"We will use nanomaterials and photons to serve as an interface between organisms and artificially engineered systems. By bringing these fields together, and creating knowledge at the discipline boundaries, we will transform our understanding of nanoscale events in living systems.

"We will create a window into the body,

Tanya Monro and colleague Dr Alexandre Francois.

with tangible outcomes from our research in areas such as reproductive health, the immune system and cardiovascular health."

The new Centre of Excellence brings together leading researchers from the University of Adelaide, Macquarie University and RMIT University with key international, national and industry partners.

ACES says its grant will allow further development of its work on smart nanomaterials to create 3D devices with advanced capabilities over their 2D counterparts. The resulting technology breakthroughs will have a direct impact on existing industries for batteries, solar cells and medical implants and provide opportunities for the development of new manufacturing capabilities.

Long-term aims of the centre include development of systems with profound implications for advances in materials development, energy conversion/storage devices, systems that interact with living tissue and soft robotics.

Planned applications included a 3D robotic prosthetic hand with a neural interface system and a solar fuel device that would use the sun to convert carbon dioxide into a fuel.

Professor Wallace says the ACES vision is to create the pre-eminent world centre for electromaterials science.

"We are well placed to take a global leadership position in 3D electromaterials science and to use this knowledge to create new industries for Australia," Professor Wallace says.

The new centre will combine research strengths from across six countries, including five new international partner organisations, bringing together leading experts in materials, modelling, fabrication and device development.

UoW's partner organisations are Dublin City University, the University of Warwick, Friedrich Alexander University of Erlangen-Nuremberg,



Gordon Wallace

Hanyang University and Yokohama National University. Collaborating organisations are Monash University, Deakin University, The University of Tasmania, The University of Melbourne and The Australian National University.

GRAEME PEARMAN IN INDIAN PROGRAM

Dr Graeme Pearman AM FAA ATSE, Chair of the Academy's Climate Change Impact Advisory Group, visited New Delhi and Mumbai recently as part of the Australian Government's science collaboration program with India.

The visit included discussions with academics primarily interested in the climate change/energy futures nexus, lectures to postgraduate students and staff, and a meeting with the major energy equipment manufacturer Thermax.

The university visits were to the Indian Institute of Technology-Delhi Centre of Atmospheric Science and the office of the Dean of International Programs and The Energy Research Institute (TERI) in Delhi. Visits in Mumbai were to the Indian Institute of Technology-Bombay, Interdisciplinary Programme in Climate Studies, Office of the CEO of the IITB-Monash Research Academy and the Head of the Department of Energy Science and Engineering.



The research seminars **Graeme Pearman** presented covered the topics: The Science Policy Interface, Limits to Biofuels and Bio-sequestration, Basic IPCC Climate Science, Climate Change Science, Society and Us, and Perspectives on Global Change Science, and Policy and Society.

The visits reinforced the view that there is significant interest and capability relevant to the climate-energy issue in these centres, and much in common with Australian science, graduate training, and technical and political interests.

But it is also very clear that substantial differences exist related to the geography, economies, histories and cultures of the two countries – leading to different investment and policy responses.

The program was managed by the Academy of Science and supported by the Department of Foreign Affairs and Trade, Austrade, the Australian Trade Commission and the Australian Consul-General's office in Mumbai.

Keith Lewis well-known as engineer and administrator



Keith Lewis

Mr Keith Lewis CB AO FTSE, one of South Australia's most distinguished public service engineers and administrators, died in Adelaide on 15 November, aged 86.

He graduated as a civil engineer from the University of Adelaide in 1952 and was awarded a Diploma in Public Health engineering from Imperial College, London, in 1955 on a Rockefeller Foundation Grant.

He joined the SA Government as an engineer in the Water and Sewerage Treatment Branch in 1952 and served in successively more senior roles until being appointed Director General and Engineer in Chief in 1974. He served in this role until 1987.

He was a member of the Electricity Trust of SA, the State Planning Authority and Environment Protection Council, and Chairman of the SA Water Resources Council. On the national water scene he was a member Australian Water Resources Council Standing Committee, Chairman of the Australian Water Research Advisory Council, River Murray Commissioner and Chairman of the Murray–Darling Basin Freshwater Research Committee.

He also served as Chairman of the Pipelines Authority of SA, the SA Energy Planning Executive and the SA Urban Land Trust, and as a Director of Amdel Ltd.

A former captain of the Kooyonga Golf

Club, in Adelaide, his professional associations included Engineers Australia, the Australian Waste Water Association, the Australian Public Health Association, the US Water Pollution Control Federation and the UK Institute of Water Pollution Control.

Mr Lewis was named a Companion of the Order of the Bath (CB) in 1981 and an Officer of the Order of Australia (AO) in 1994.

A Fellow since 1982, his nominators and supporters then rated him as "one of Australia's most able technologists and administrators".

PAUL ZIMMET WINS PETER WILLS MEDAL

International diabetes and obesity expert, Professor Paul Zimmet AO FTSE has been awarded The Peter Wills Medal by Research Australia.

Director Emeritus at the Baker IDI Heart and Diabetes Institute in Melbourne, Professor Zimmet was recognised for his outstanding contribution to building Australia's international reputation in health and medical research and fostering collaboration for better health. Professor Zimmet, a Fellow since 2005, is acknowledged for raising the awareness of diabetes as an international public health emergency and helping to enhance the understanding of diabetes, improved care and prevention in many nations around the world.

He established Australia's first dedicated diabetes institute in Melbourne in 1985, and in the ensuing 20 years, the International Diabetes Institute (IDI) became the largest diabetes

research institute in Australia. The IDI merged with Australia's largest heart research institute in 2008 to become the Baker IDI Heart and Diabetes Institute.

Professor Zimmet's pioneering work in Pacific and Indian ocean nations has been pivotal in informing the global growth of diabetes. His epidemiological research covering many ethnic groups in Australia and Pacific and Indian ocean nations has contributed to the classification and diagnostic criteria for diabetes and improved understanding of the genetic-environmental and behavioural components of type 2 diabetes.

He has served on many national and international diabetes committees, most notably for the World Health Organization and for the International Diabetes Federation (IDF). In 2010, he received the Grand Hamdan International Prize for Medical Sciences in the field of Diabetes Mellitus. In 2013, he was made one of the few international members of the Spanish Royal Academy of Medicine.

Professor Zimmet spearheaded a landmark Australian study on diabetes, obesity and lifestyle (AusDiab), the largest national study in any developed nation to do glucose tolerance testing on all subjects.



Paul Zimmet (left) with Research Australia Deputy Chair Mr Peter Wills AC.

He has campaigned tirelessly for government support towards tackling the diabetes epidemic and has also been a key advocate in highlighting the plight of indigenous communities in regard to chronic diseases.

Sir Gustav Nossal AC CBE FRS FAA FTSE is a previous winner of The Peter Wills Medal.

NEW FELLOWS GET CERTIFICATES



New Fellows Professor Maria Skyllas-Kazacos, Emeritus Professor, Chemical Engineering and Industrial Chemistry, University of NSW, and Professor Graham Davies, Dean of Engineering, University of NSW, receive their Academy Fellowship certificates from NSW Chair Dr David Cook (centre) in December.

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UQ SCIENTISTS PROTECTING GLOBAL FOOD SUPPLY



If the earth continues to warm as scientists expect, civilisation faces the very real prospect of many major food crops failing through repeated periods of extended drought.

Scientists from UQ's Queensland Alliance for Agriculture and Food Innovation (QAAFI) have been working with colleagues at the Queensland Department of Agriculture, Fisheries and Forestry (DAFF) in an international collaboration to improve sorghum productivity under drought conditions. Underpinning the research is a \$4 million grant from the Bill & Melinda Gates Foundation, supported by the research expertise and resources of UQ, DAFF and the Ethiopian Government.

Sorghum is the world's fifth most important cereal and is critical to food security in Africa where the crop's capacity to better tolerate drought, high temperature, and low fertility often make it the preferred crop to maize.

The QAAFI team is led by one of Australia's most experienced sorghum plant breeders, Associate Professor David Jordan, and sorghum crop physiology/modelling authority, Professor Graeme Hammer. The project brings together sophisticated computer modelling technologies and the latest methods in plant breeding, with a major focus of the work on enhancing the skills and capacities of the sorghum crop improvement

program in Ethiopia. It's a project that's expected to generate benefits well beyond the initial target countries and Australia. The trait-discovery component of the project has the potential to deliver global benefits for drought adaptation of crops.

Improving drought tolerance in sorghum is only one of the many global problems QAAFI scientists are currently addressing.

Each year, QAAFI trains more than 70 research higher degree students in plant, animal, food and nutrition sciences. Learn more about QAAFI at qaafi.uq.edu.au

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

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