



FOCUS

NUMBER 187
DECEMBER 2014

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- Managing the development and execution of our programs; and
- Supporting relationships with international communities.

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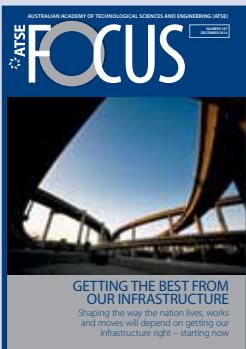
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Front cover: Freeways intersect in Los Angeles.
PHOTO: iStockphoto



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FOCUS

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

Deadline for the receipt of copy for next edition of *Focus* is
16 January 2015.

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ACN 008 520 394
ABN 58 008 520 394
Print Post Publication No 341403/0025
ISSN 1326-8708

Design and production:
Coretext 03 9670 1168 www.coretext.com.au





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- University power engineering teaching and learning provides relevant industry skills
- Value added continuing professional development programs
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PHOTO: ISTOCK



A role for social media in infrastructure planning?

Infrastructure: from the past into the future

Social media might have a role in public consultation to formulate community aspirations that could supplement, rather than supplant, our current well-tried political processes.

Although *public infrastructure* is a widely used term, a definition is useful. A common meaning is that it refers to the various systems such as transport, water supply and sewerage that underlie the daily operations of an active community and which are usually means to some other ends.

The provision of infrastructure begins with the community having the foresight to assess an important future need that will not be satisfied unless action is taken. It then decides what specific action is needed and ensures that that action occurs.

Typically, public infrastructure cannot be provided by normal commercial processes

as it cannot be financed and operated on the basis of charges made for its use. Many of the reasons for this stem from the fact that infrastructure systems can be very large and require considerable foresight, long-term planning, compulsory acquisition of land and access limitations.

Typical schemes might well take more than a decade to plan, design and construct. Consequently, acceptable usage charges often fall short of financing and operating costs and capital investments provide low direct rates of return. Indeed, their operations may need to be subsidised.

Most transport infrastructure fits easily into this categorisation. For example,

around the world public transport systems have typically collected about half their operating costs from the fare revenue. We need to adopt better ways of capturing the value added by infrastructure investments.

Pricing of infrastructure usage is often a vexed issue.

One of the efficiency lessons of the 20th century was that charges for the use of any product should at least equal the marginal costs of providing that product. This rule has yet to be applied to much road usage, where users assume that the product is free. Pricing road usage is now relatively straightforward, but we have yet to see any government embrace the process.

On the other hand, much of the benefit of infrastructure provision is reflected in increased land values. This is readily captured by taxes on land value, but again is rarely used (it is more common in the US where municipal bonds are used to fund municipal improvements).

In Melbourne, the massive changes in land use that have occurred along the Western Ring Road since it opened 20 years ago are indicative of the uncaptured value that is added by a typical piece of transport infrastructure. The value-captured approach indicates that transport infrastructure will usually be a very good investment and so it is surprising that so many current governments restrict their expenditure to funds raised in their annual budgets and are unwilling to borrow. It has recently been strongly advocated by bodies like Infrastructure Australia and the Committee for Melbourne.

The first problem in infrastructure provision is to foresee what the community will need some decades ahead. This cannot be done with certainty and a rational approach would be to consider a number of possible scenarios, each with its estimated probability of occurrence.

When one scenario is selected, some *hedging* provisions should be made in case one of the alternative scenarios occurs.

Some of the events that will determine the future will be beyond the community's control, but many are a consequence of the community's current aspirations. For example, does it want to expand into new territory, develop new industries, change the way in which people travel, preserve some threatened natural features?

Two key parameters that can be used to illustrate infrastructure issues are *land use* and *population*. Planning and then defining future land use gained momentum during the Romantic / City Beautiful movements in the 19th century and the momentum continued into the 20th century.

It fell into some disrepute for a number of reasons.

First, it tended to produce sterile, segmented outcomes as its underlying objections were seen, in retrospect, to be far from community aspirations.

Second, it inhibited land speculation, which was otherwise the source of much legitimate and illegitimate wealth accumulation.

Third, planning had become the core

of many of the policies of Marxist-based governments and the rigid nature of the plans and their very poor outcomes gave much ammunition to planning opponents.

This combination of events meant that effective planning was uncommon during the 20th century, particularly under right-wing governments and pressures from free markets.

The estimation of population size is a core design factor for most infrastructure plans. I once reviewed the models used in planning Melbourne's transport during the 20th century. The errors made by careful, serious planners were enormous. A long-term plan produced in the 1950s so underestimated population growth that the design population had been reached by 1971.

The next plan in the late 1960s estimated Melbourne's 1985 population to be 3.6 million. In 1985 it was actually 2.7 million. The forecasting problem is not unique to Melbourne. An international retrospective review of road projects in the last third of the 20th century showed that in a quarter of the projects the difference between forecast and actual conditions exceeded 40 per cent.

Of course, predicting the future is

Multiple challenges for infrastructure planning

Australia faces a number of challenges to providing effective and adequate infrastructure.

The nation must come to grips with an existing backlog of infrastructure investment, including the potential decay of existing infrastructure.

Population growth and the impacts of climate change will further exacerbate these inadequacies.

The nation's ability to mitigate, respond to and recover from natural disasters will be an ongoing fundamental requirement.

In addition, declining investment in mining infrastructure will change the mix of investment in public infrastructure, requiring a strategic plan to ensure sound infrastructure provision, job creation and economic growth.

These are key points made in the Academy's new Infrastructure Position Statement – **'Infrastructure to Meet Australia's Future Economic, Environmental and Social Needs'** – which is circulated with this edition of *Focus*.

It says addressing Australia's infrastructure challenges requires a shift in the current model for implementing change in Australia.

Public engagement will become the first critical step in decision-making that considers national aspirations and the environmental,

economic and social benefits and impacts.

It says Australia must commit to robust, long-term infrastructure planning, noting there is a need to develop a clearer understanding of the Australian context in 15 to 30 years. This will identify major national infrastructure needs and assist to align infrastructure spending and maintenance with national macro socio-economic policy. This long-term planning will boost the confidence of engineering and other firms to invest in the most modern and productive equipment and technology that needs to be amortised over several projects.

Cooperation between political parties and at all levels of government is required, alongside introduction of a formal consultative mechanism at the earliest possible planning stage that attempts to resolve differences as quickly as possible.

Governments need to follow through on their commitments to the development of robust and integrated long-term strategic plans for our cities, it argues.



The Infrastructure Position Statement is on the ATSE website.

not a simple task. A Planning Officer apocryphally said “If I could predict the future I would be lying on a beach in the south of France, not working as a mid-level State public servant.”

The critical nature of population forecasts was at the core of the 1990s study led by Barry Jones (Hon Barry Jones AC FAA FTSE FAHA FASSA), which investigated Australia’s population carrying capacity. It suggested an optimum population of 23 million. Our population is now 23.6 million. The importance of the work was not so much in any absolute numbers generated but in the realisation of the range of issue that are involved, many of which would be strongly influenced by direct or implied decision-making as population depends on many factors in addition to fertility and death rates. The largest current factor is our net immigration from overseas.

In infrastructure planning it would seem logical to begin by defining our aspirations and estimating long-term conditions that are beyond our control – as key design factors such as population size could then be estimated and we could select infrastructure that would enable us to meet those aspirations and conditions, and plan for its timely delivery and operation.

Considering the need to identify land requirements and the time it takes to plan and deliver infrastructure, implies planning and rolling budgets extending forward for, perhaps 15 years. Such a model was behind the recommendations flowing from ATSE’s 2013 Infrastructure Planning Workshop.

It is fair to say that the model could be placed in the motherhood category, but its principles must be repeated and resaid because they remain more honoured in the breach than in the observance.

Why is this so? In 2009 COAG agreed that infrastructure budgets should be set over at least a 10-year period, taking them beyond two electoral cycles – a wise decision, but one yet to be implemented by any of COAG’s constituents.

And do we determine our aspirations

before deciding what we need to build to achieve those aspirations? Here things are a little more promising for, after Campbell Newman was elected Premier of Queensland in 2012, one of his first acts was to produce a set of State aspirations leading to reports such the 2014 *Governing for growth: economic strategy and action plan*. In addition, Infrastructure Australia has been steadily working towards

In 2009 COAG agreed that infrastructure budgets should be set over at least a 10-year period, taking them beyond two electoral cycles – a wise decision, but one yet to be implemented by any of COAG’s constituents.

a coherent rolling program of work, although the full pattern is yet to emerge.

However, the debate about infrastructure in the lead-up to the recent Victorian election was disappointing, with candidates on both sides seemingly pulling transport schemes out of a magician’s hat with little debate about long-term planning. Worse still, voters appeared to accept this as a reasonable process.

Nicholas Reece, a Melbourne academic, was particularly scathing, commenting that “infrastructure decisions had become a political football and the both Parties had more transport positions than the KamaSutra”. I use the Victorian case only because of its immediacy to me in time and place. I could easily have chosen cases from other jurisdictions such as NSW during previous electoral cycles.

I have spoken glibly about “the community’s current aspirations”. But what are they and why are they never considered, debated and formulated? Perhaps the task of establishing a forward vision and the planning and building to achieve it is beyond our current political processes. In a recent review Mark Triffit, of the University of Melbourne’s School of Government, observed that “parliaments and politicians seem increasingly incapable of resolving the big challenges of our time as sound, future-focused policy is constantly overtaken by gridlock and spin”.

He observed that the immediacy of the internet and of social media was reducing the ability and desire of politicians to take long-term strategic stances.

Consequently Mr Triffit suggested that there might be a role for social media in public consultation and that it could be formalised into policy-making. He also suggested that there could be “scope for expert panels – insulated from short-term

political and media pressures – to steer and decide on important policy issues”.

Considering these suggestions, it could be possible to use the new media to formulate aspirations by a process of wide review, input and consultation. Desired futures could be postulated and then considered at all levels, priorities could be discussed and probable outcomes could be predicted. Expert groups could be tasked with openly producing possible policies and processes which would allow realistic aspirations to be achieved.

This could be done by processes which use the new social media and cloud technologies to supplement rather than supplant our current well-tried political processes. ▀

DR MAX LAY AM FTSE, a Fellow since 1985, is a world expert in road and transport engineering. He has held senior appointments at the State Electricity Commission of Victoria, BHP Engineering, the Australian Road Research Board (ARRB), VicRoads, SKM and private consultancies. He was a Director of ConnectEast, Melbourne’s Eastlink operator, has been an adviser to Roads Australia on road pricing and in 2009 was awarded the John Shaw Gold Medal for his outstanding service to road transport in Australia. He was President (1995–96) and Councillor (1978–2002) of the Royal Society of Victoria, a Director (1986–2002) and President (1999–2002) of RACV, and President of the Australian Automobile Association (2000–02).

**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.

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By Cynthia Mitchell

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Revolutionising how we think about infrastructure

We need broad-scale revolutionary, rather than evolutionary, change if all seven billion people on the planet now, and those who follow us, are to have the opportunity to live well.

Across the globe, most of us now live in cities and the way we live in cities is fundamentally enabled or disabled by a city's infrastructure.

Despite our best intent, the way we live in cities is also mostly unsustainable, as leading international work on planetary boundaries makes clear. This work, demonstrating that we are either transgressing or approaching the limits of most of the Earth's fundamental resources and processes, is supported nationally and taken seriously at the highest international levels of public and private sectors.

It underpins the UN's forthcoming global Sustainable Development Goals and the World Business Council for Sustainable Development's Vision 2050.

Functional infrastructure (transport, energy, telecommunications, water, stormwater and sewage services) is fundamental to functional people and functional cities. And, what 'functional' means has always reflected our expanding understanding of the world around us. For example, in the water sector, our historic intent was to protect public health, and then to do so at the lowest cost, and then to reduce harm to the environment and, more recently, to enhance 'liveability'.

Revolutionary change

However, what the planetary boundaries analysis makes clear is that we need broad-scale revolutionary, rather than evolutionary, change if all seven billion people on the planet now, and those who follow us, are to have the opportunity to live well.

Since infrastructure underpins the metabolism of our cities, it is central to the revolution. The idea presented here – 'restorative' or 'regenerative' or 'net-positive' infrastructure – is deliberately aspirational, provocative and revolutionary.

Istanbul's new massive sewage treatment plant, under construction in 2011, raises the question – smaller numbers of larger facilities, or larger numbers of smaller facilities?



Simply put, 'restorative' or 'regenerative' or 'net-positive' systems seek to 'do more good' rather than to 'do less bad', because doing less bad will not, and cannot, deliver a world where we can all live well. The question we need to ask and begin to answer is what would constitute net-positive infrastructure?

The impact of regenerative, restorative, net-positive thinking, while new to infrastructure, has been profound in the product and green building sectors.

In *Cradle to Cradle*, McDonough and Braungart tell the story of how a 'do less harm' approach can lead to book designers choosing maximum recycled content for the paper as a trade-off between minimising the use of chlorine as a bleaching agent and minimising the use of virgin forest materials, thereby reducing the options for

further recycling because of reductions in fibre length each time paper is recycled.

A 'do more good' approach, if it chose to keep the traditional form of a book, might instead choose, as McDonough and Braungart did, a polymer-based material that they say is designed to be durable (for "infinite cycles at the same quality"), to be compatible with non-toxic inks that can be removed in a process that uses only heat and water; and so forth.

My background in chemical engineering and thermodynamics tells me that there is no free lunch, ever, so while being sceptical of overly positive claims, I am nonetheless certain there is room to swing our compass in this direction.

What we are talking about here is the scale of transformation that economists have recognised only occurs

"Net Zero Energy and Net Zero Water buildings have rapidly captured the public imagination, and are transforming expectations for the pace of change in the built environment."

– Net Positive Energy + Water Building Conference,
4-5 February 2014, San Francisco, <http://living-future.org/netpositive>



A urine-diverting toilet – our engagement with infrastructure could be further upstream than we think. UTS has installed urine-diverting pipework in its new Faculty of Engineering and IT building because of the opportunity it presents to learn how to capture and reuse valuable nutrients.

every few generations – the end of one economic 'long wave' and the emergence of another enabled by the combination of creative capital and technological innovation (for example, steam trains) that drive socio-political change. This time, the combination is the incredible shifts enabled by IT (for example, big data and the cloud to give real-time everything) and dematerialising (service, sharing and circular) economies.

What might this mean for our infrastructure systems? It would mean recognising that our key design parameters (for example, demand) are shifting, gradually transforming and diversifying not just the physical infrastructure, but also the systems that surround it.

Some near-term thought experiments follow to begin to explore possibilities ...

What about a net-positive motorway (assuming that is not too much of a contradiction in terms)?

- It might give people feedback about the impact of the decisions they are making in how and when they are using the motorway;

- It might send price signals based on the number of people in an Uber car (the San Francisco-based cab hire service) as well as time of day;
- It might make formal and informal public transport central;
- It might preference cyclists; and
- It might encompass wildlife corridors through value capture.

In the water sector, our environmental regulation system might enable and incentivise sewage service providers to 'separate' upstream – so that recovery of valuable or dangerous materials is facilitated at the scale and location that makes most sense, or we might engage the public in a well-informed deliberative process to come to new agreements about what level of risk, security and price are preferable.

In energy, it might mean opening to consumers the \$39 billion of predicted network investment in Australia to manage peaks, offering incentives to shift the timing of our electricity demand.

It might facilitate breakthroughs in our technological systems, the institutions that surround them, and the scale on which we think of infrastructure interventions.

Is all this 'pie in the sky'? Maybe not.

In the US, Harvard University combined forces with the American Society of Civil Engineers, the American Public Works Association and the American Council of Engineering Companies to form the Institute for Sustainable Infrastructure (ISI). While ISI was under development at the same time as our own Infrastructure Sustainability Council of Australia (ISCA), ISI has gone much further, setting 'restorative' as the highest level of performance in its infrastructure rating tool.

What next?

I first pitched this idea of restorative infrastructure back in 2006 – initially to Yarra Valley Water (where it helped define its 'new' objective of providing services within the carrying capacity of nature),

then to the Sydney Harbour Foreshore Authority where it transformed what people thought was possible for Barangaroo at a building and precinct scale, then to ISCA (at that time the Australian Green Infrastructure Council), which eschewed it as a bridge too far at that point.

Embracing this is seriously challenging but necessary work – to identify what this would mean in practice in physical, institutional and economic terms and what initial moves we should make and to be able to learn from recent failure, while also scrutinising with new lenses things we hold dear that have served us well historically.

The bottom line is that we have taken a significant step up in our understanding of our interactions with the Earth's systems, so it is time to take the next significant step in our definition of 'functional' and to articulate new, revolutionary and changing expectations of our cities' infrastructures over the full term of their functional life.

ATSE has an extraordinary opportunity to play a central leadership role, nationally and internationally.

ATSE could take up the planetary boundaries concept that has proven itself globally as a useful starting point for discussion across business and government and facilitate a broader conversation in Australia about what we want our society to be, how that relates to our fair share of the planetary boundaries, and what that means for how to make the most of our existing infrastructure and how to put our incredible ingenuity into conceptualising, designing, financing and operating revolutionary new infrastructure.

An earlier version of parts of this article appeared in the Australian Water Association journal, Water, in October 2014.

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By Rob Fitzpatrick
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Waste not, want not: making better use of what we've got

Financial, telecommunications and retail sectors integrate data analytics to make sense of the volume and complexity of data. Infrastructure planners and providers must do the same.

Despite the political attractiveness of ribbon-cutting events, simply 'pouring concrete' for the next big motorway won't produce the dynamic, cost-effective infrastructure Australia needs.

Given the economy's fiscal constraints, investment in public infrastructure needs to provide the best value for public money possible.

Without question, public infrastructure investment can be better informed, funded, designed, constructed and operated by using Smart information and communications technology (ICT) – leading to better value for governments, business and taxpayers and greater productivity from the assets themselves.

Smart ICT can also optimise the use of existing infrastructure and enable better decision-making about which new infrastructure to invest in the future.

Smart ICT enables better, more insightful consideration of the issues and decision-making at the planning stage, minimises risk and uncertainty during the build phase, and provides higher operational efficiencies throughout the life of the asset. As computational power and our ability to handle algorithmic complexity grow, these techniques and tools will provide even greater ability to reduce cost and improve productivity.

The financial services, retail and telecommunications sectors have in recent years adopted new innovative technology and tools (or Smart ICT) to fundamentally transform their business models and processes. Now is the time for the infrastructure sector to follow suit.

Smart ICT holds the key to addressing Australia's funding constraints and should be woven into the DNA of design, funding, construction and operational phases of public infrastructure, becoming

a core requirement in the consideration process for any new investment.

What can it do?

Technological advances during just the past three to five years have created the capabilities we now call Smart ICT – providing unprecedented insight into major projects at critical points.

Smart ICT describes tools, techniques and capabilities – data analytics, optimisation, modelling and software systems, networked sensors, integration with mobile devices and new ways of gathering data, such as social media and crowd-sourcing – which can be applied to:

- Predicting future demand for freight and passenger traffic movements in key transport corridors around Australia;
- Informing preventative maintenance on major infrastructure such as bridges, road and rail networks;
- Optimising rail container handling between port quaysides and inland intermodal terminals to improve goods flow both ways;
- Integrating crowd-sourced social media like Twitter into traffic management operations to improve incident notification, and reduce

clearance times and congestion;

- Assisting managed motorways to operate with dynamically tuned ramp-metering algorithms, lifting throughput in peak periods; and
- Optimising traffic signalling in urban areas to reduce the drag on productivity caused by congestion.

There are already plenty of real-world examples.

Lima, the nine-million-resident capital of Peru, is a city with a big air pollution problem. It has introduced a billboard that 'breathes' in air, purifies it and breathes it out again, reportedly improving air quality for a five-block radius.

Commute times in Los Angeles dipped by more than 12 per cent after a new traffic control system, using pattern analysis and sensors in the road to manage signals, was introduced.

Closer to home, NICTA has injected Smart ICT thinking into predicting which critical water mains – the vast network of pipes that lie under our streets – are most likely to fail. This technology is being taken up by water utilities around the world, leading to dramatic savings in maintenance costs – not to mention far less disruption, chaos and congestion.

THE G20 FINANCE MINISTERS AND CENTRAL BANK GOVERNORS STATED EARLIER THIS YEAR:

“... productive infrastructure is critical to Australia's future competitiveness and economic growth. It is imperative that Australia invests in infrastructure projects that address debilitating bottlenecks and build the capacity Australia needs for the 21st century.

Investing in the right infrastructure can boost Australian incomes by improving quality of life, and increasing productivity, including by tackling congestion, reducing business input costs and by helping firms better link with their employees and customers. The acceleration of infrastructure expenditure is a challenge, given that the fiscal positions of both Commonwealth and State Governments remain constrained. All levels of government are therefore looking at ways to address funding constraints.”

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Dr Fang Chen, Intelligent Water Pipes Project Leader at NICTA.

There are obvious examples of where Smart ICT has improved/can improve the performance or reduced the cost of infrastructure across the different stages of the infrastructure lifecycle:

SMART ICT IN PLANNING AND DESIGN

Medium- to longer-term large-scale planning decisions can now be made with far greater certainty than ever before. Additionally, better integrated decision-making can be made on how major facilities – such as airports – will affect other infrastructure such as road and rail links, transport interchanges and inter-modal terminals.

The latest ‘machine learning’ can integrate data from multiple sources, ‘fill in the gaps’ where databases miss records, build ‘non-parametric’ models that don’t need expert opinion to define core operating assumptions, and apply multiple filters to algorithms that can predict with high accuracy what outcomes are likely.

New optimisation techniques factor in real-world complexity and operating constraints in ways that have not been possible until recently.

Thus, for infrastructure planners and operators an alternative to lane widening can be to increase freeway capacity through relatively low-cost and fairly easily installed technology that may satisfy demand for a decade or more. In this way, Smart ICT can

preserve the performance of very expensive transport assets and extend the life (i.e. increase the productivity) of those assets.

CONSTRUCTION MANAGEMENT 2.0

Data analytics and optimisation can unlock significant value during the construction phase of major infrastructure projects. Project management – prioritising, scheduling and managing the delivery of multiple components, trades and essential services – is an already complex optimisation task. Rarely does a project proceed without some major component being rethought, replanned and redesigned, with knock-on effects across the balance of the project. Complicated construction projects can be managed more efficiently by using Smart ICT to deal with changing externalities and priorities.

Infrastructure is dynamic

Major infrastructure projects need to accommodate changing use and demand profiles through their long life cycles – what was designed in one decade, or one era, may change as the surrounding city changes. Modelling ‘future states’ to predict the impact of changing demand profiles on existing infrastructure underpins maintenance and reinvestment decisions.

In NICTA’s work with many public and private sector organisations, identifying and analysing data to optimise

business is increasingly becoming one of the most critical factors to success, providing deeper insight and consequently more informed decision-making.

The cost of access and ‘urgency’ involved in reactive repairs and maintenance typically means that preventative maintenance can be carried out at around one-tenth of the cost. Predictive tools can help prioritise maintenance spend to those elements most likely to fail, thus avoiding or delaying billions of dollars in major capital outlays.

From 24/7 remote monitoring of bridges, automatically alerting asset managers to the ‘structural health’ of critical components, to dynamically and optimally adjusting the timing of traffic signals to reduce congestion, Smart ICT can ensure that infrastructure automatically responds to demand and environmental changes to achieve better operational performance.

As Australia’s Productivity Commission reported in March 2014, there are numerous examples of poor value for money arising from inadequate project selection. Without reform, more spending will simply increase the cost to users, taxpayers and the community – and lead to wasteful infrastructure builds.

To address this, both public and private sector organisations need a coordinated and coherent data collection process, enabling detailed analysis of the costs and productivity of infrastructure construction, and of the effects of various governmental policies.

Smart ICT must be woven into the DNA of all phases of public infrastructure investment – planning, design, development and operations.

MR ROB FITZPATRICK is Director Infrastructure, Transport & Logistics at NICTA (National ICT Australia). He has an extensive background in business and technology in the ICT sector globally, as a management consultant, corporate executive and entrepreneur. He has an active portfolio of ICT businesses and is an adviser to Australia’s research and higher education sector. He has been involved in major projects and infrastructure delivery for nearly three decades – starting as national research manager with the Property Council of Australia before spending eight years with worldwide management consultancy McKinsey & Company.

By David Singleton

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PHOTO: ISTOCK

Australian suburbs, where the 'silent' stakeholders live.

Infrastructure priorities for Australian cities

A mature debate is needed about what constitutes a sound infrastructure investment.

Australia is facing two difficult decades and must come to grips with a backlog of infrastructure investment that has been, and will be, exacerbated by population growth and the impacts of climate change.

Australia's lack of transparency in infrastructure decision making has often led to inefficiency and community distrust and has constrained informed debate about the implied trade-offs – which projects, service outcomes, prioritisation, funding, and so on.

Publishing the technical underpinnings of strategic plans and project business cases (or at least their key findings and assumptions) would improve the public's ability to scrutinise political promises and, perhaps, be comfortable with the outcomes.

In the period to 2061 and on 'medium' projections, the combined population of Australia's capital cities will grow by nearly 16 million and the proportion

of Australians living in a capital city will significantly increase – from 66.0 per cent in 2011 to 69.3 per cent in 2031 and 73.4 per cent in 2061.

These projections are for Melbourne to grow to 8.6 million by 2061, Sydney to 8.5 million, Perth to 5.5 million and Brisbane to 4.8 million.

This growth will significantly increase the demand for movement by freight and people. It will also increase investment in both new transport infrastructure and in the upgrading of existing networks that will be necessary, as has been the trend over the past few decades.

In the case of the movement of people, both road and public transport investment will be necessary; freight movements will predominantly require road investment and freight railway facilities (see Figure 1).

In a period of scarce capital supply and competing priorities for investment, a mature debate is needed about what

constitutes a sound infrastructure investment.

There is no shortage of capability within the sector for assessment of complex, multi-faceted infrastructure proposals, allowing for community engagement as appropriate. But how are such investment projects selected and evaluated? Unfortunately, there are several past examples of poor decision-making, poor proposals and inadequate evaluation.

We need to employ a transparent process so that decisions about what kind of infrastructure we require can be made in a sensible way to ensure the community understands the rationale for the decisions made.

In considering the stakeholder engagement processes it is important that the debate is not skewed toward those that have access to infrastructure already or who stand to gain the most from infrastructure investment. The

stakeholder who is not represented in the conversation is probably one of the more important parties to the decision.

We need to be cognisant of how the 'silent' stakeholder is affected by our infrastructure decisions, be they from a lower socioeconomic group, a future generation, an unrepresented minority or simply the under-informed.

Our infrastructure investments are becoming more and more expensive.

Who should be paying for them and where is the funding to come from? We must find new ways of funding infrastructure, based on criteria that reflect the benefits generated, such as user and beneficiary charging models, value capture and levies.

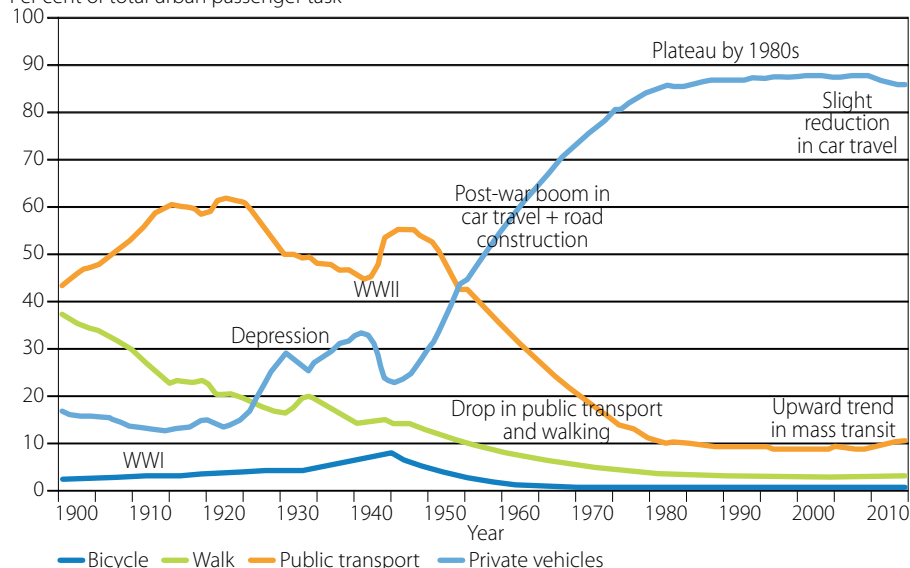
Recycling capital through the sale of existing (state) brownfield assets and investing the proceeds in new greenfield projects should be, and is being, pursued.

The need for a 'new' way forward is clear. Investment in infrastructure is an investment on behalf of current and future generations.

At present we are, for the main part, using up infrastructure provided by our predecessors. We should be investing to meet the needs of current and future generations. We can consider such investments as vehicles for intergenerational wealth transfer, as our current day investments in infrastructure enable future generations to achieve a higher standard of living.

It is important that these asset investments are optimal. Ongoing tight fiscal circumstances will increase the pressure on governments that seek to justify committing large sums to infrastructure projects. Rebalancing investment priorities to give greater attention to the maintenance of existing assets, managing demand on existing networks and targeted, comparatively inexpensive investments at pinch points, are more likely to provide a durable, long-term set of solutions to Australia's infrastructure needs.

Figure 1 Proportion of metropolitan distance travelled, by mode, 1900 to 2010. Per cent of total urban passenger task



SOURCE: DEPARTMENT OF INFRASTRUCTURE AND REGIONAL DEVELOPMENT, 2012, FROM D COSGROVE (BITRE) 2011

In considering the stakeholder engagement processes it is important that the debate is not skewed toward those that have access to infrastructure already or who stand to gain the most from infrastructure investment. The stakeholder who is not represented in the conversation is probably one of the more important parties to the decision.

Increasing the utilisation of our existing infrastructure relies on one of two things occurring:

- Increasing the usage of the assets by smarter management, by balancing 'directional' demands and by managing peak periods; or
- Increasing the density and the land use of our city blocks to improve the utilisation of existing infrastructure assets.

We should consider both high-value, low-cost infrastructure investments, as well as the significant, high-cost projects that tend to be politically popular.

There is widespread agreement that investment in our cities is vital to the economic development of Australia. This is in turn an investment in our communities and we should reflect on

the fact that communities are made up of people, buildings and infrastructure.

The former both rely on the infrastructure: we must get that investment right.

MR DAVID SINGLETON FTSE is a board chairman and non-executive director, a respected thought leader and expert adviser to governments and global businesses on resilient leadership and practice, specialising in infrastructure, business sustainability and climate change resilience. He is a member of the Swinburne University of Technology Board, a Director of Standards Australia Ltd and Chairman of the Infrastructure Sustainability Council of Australia. He worked with the global consultants Arup for 41 years, holding a series of global and regional leadership roles. He was a Director of Arup Group Ltd, the global holding company, from 2001–11, and was responsible for the strategic leadership of Arup globally.

**LETTERS
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Crisis and opportunity: time for a national infrastructure plan

Canada's infrastructure, along with the institutional frameworks that fund and finance these assets, are in need of repair.

Australia is not alone in needing strong and consistent investment in infrastructure. There is much it could learn from Canada – a larger and older country with, in many cases, opposite issues to those faced by Australia, but at the same time sharing many of the challenges of climate, distance and federalism.

In a recent article by think-tank Canada 2020, the authors said infrastructure was central to every aspect of life in Canada – driving productivity and growth in a modern economy, contributing to the health and well-being of Canadian citizens, transporting goods and services across the country, enabling communication, providing core services such as water, electricity and energy and shaping the growth of communities and how they contribute to its collective social fabric.

“And, yet, across the country, Canadians are impacted by infrastructure that has failed to be maintained or that remains to be built. This is apparent in the deterioration of our roads and highways, the over-capacity of our public transit systems, underinvestment in affordable

CANADA 2020

Ottawa-based Canada 2020 describes itself as the nation's “leading independent progressive think-tank”, the objective of which is to inform and influence debate, to identify progressive policy solutions and to help redefine federal government for a modern Canada.

In a recent article, ‘Crisis and Opportunity: Time for a National Infrastructure Plan for Canada’, authors John Brodhead, Jesse Darling and Sean Mullin make the case for immediate federal involvement in Canadian infrastructure planning – “it should no longer be a question of if we need to devote more resources to public infrastructure ... the question ... is how the federal government should engage and in what form and capacity.”

housing and social infrastructure, and the increased prevalence of environmental incidents, such as flooding in our urban areas,” the article's authors said.

“Canada's infrastructure, along with the institutional frameworks that fund and finance these assets, are in need of repair.”

The economic case for investing in infrastructure had never been stronger, the authors said.

“In recent years – and particularly in the aftermath of the financial crisis – a consensus regarding the positive economic benefits of stronger infrastructure spending has emerged among economists and policymakers.

“In addition to the non-economic benefits of infrastructure, a dollar of infrastructure spending has a positive

effect on economic conditions in two ways – *in the short term*, by supporting jobs and businesses, leading to lower levels of unemployment and higher levels of economic growth; and, *in the long term*, by boosting the competitiveness of private businesses, thereby leading to greater wealth creation and higher living standards.”

Quoting a Conference Board of Canada report, they noted that for every \$1 billion in infrastructure spending, 16,700 jobs were supported for one year – not just in the construction sector but in as manufacturing, services, transportation and financial sector employment.

Examining the impact of infrastructure spending on GDP growth had found similar results, they said. The same Conference Board report estimated that for every \$1 billion spent, GDP would be boosted by \$1.14 billion, resulting in a multiplier effect of 1.14. Other studies had shown similar effects, with estimated multipliers ranging from 1.14 to a high of 1.78.

Virtually all recent studies estimated the multiplier to be greater than 1.0, implying that every dollar of spending on public infrastructure boosted GDP by more than one dollar – thus, infrastructure spending generated a positive economic return before projects were even completed, as the construction stage alone generated enough economic activity to justify the expense.

COST OF INADEQUATE PUBLIC INFRASTRUCTURE:

Inadequate public infrastructure is a threat to long-term economic growth. Inadequate public infrastructure lowers economic potential in a direct and obvious way according to this simple progression:

- Inadequate infrastructure results in increased costs for business;
- Increased costs result in lower return on private investment;
- Lower returns – profits – mean less money for business to re-invest in new plants, machinery and technology;
- Less investment means fewer jobs and less productive labour; and
- Lower productivity means less economic output and lower personal incomes.

The end result is a loss of competitiveness and lower rates of economic growth.

SOURCE: *At The Intersection: The Case for Sustained and Strategic Public Infrastructure Investment*, Canada West Foundation (2013).

However, they said, the most important economic benefit of public infrastructure was the long-term effect it had on productivity and business competitiveness, which were critical components of a modern, growing economy. Investments in public infrastructure, such as roads and transportation systems, communication infrastructure, utilities, water and wastewater systems, and health and social infrastructure, resulted in lowered business costs and increased labour productivity.

Lower business costs resulted in increased private sector returns, allowing for higher rates of private investment and ensuring Canadian companies could remain competitive and grow on a global stage. Similarly, increased labour productivity resulted in higher wages and greater wealth creation for Canadian citizens.

The Conference Board had estimated that roughly a quarter of all productivity growth in recent years was a result of public infrastructure investment and, looking over a longer period of time, Statistics Canada estimated that up to half of all productivity growth between 1962 and 2006 could be attributed to investment in public infrastructure.

Finally, they noted that increased economic activity and higher productivity rates allowed government to recoup a portion of its initial investment through higher tax revenues. Although estimates varied, the Conference Board study estimated that governments recovered 30 to 35 per cent of every dollar spent on public infrastructure through higher personal, corporate and indirect taxes.

Investment in public infrastructure had an immediate, short-term benefit to the economy, while also ensuring that businesses remained competitive in the long run.

The time to invest is now

While the general case for investing in public infrastructure was clear, current economic conditions created an even more compelling rationale for investing in infrastructure – right now, the authors said.

Canada was at a unique moment in time where the need for a stimulative macroeconomic policy, historically low long-term interest rates and a large

The William Dargan Bridge, Dublin

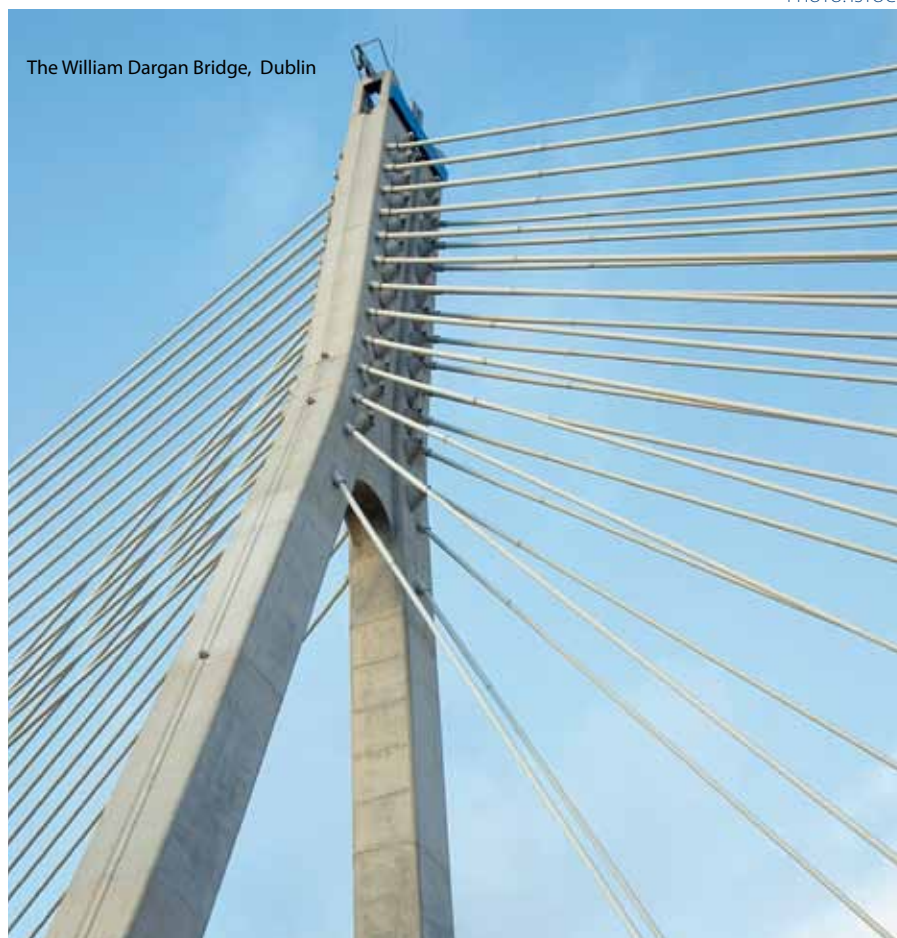


PHOTO: ISTOCK

infrastructure deficit combined to dictate the need to accelerate the rate of investment in public infrastructure.

Areas that required immediate investment included:

- Urban and Municipal Infrastructure – currently at breaking point, with an estimated municipal infrastructure deficit is \$123 billion growing by \$2 billion annually;
- Road Networks, Transportation and Electricity Infrastructure – with the Canadian Chamber of Commerce estimating that congestion is costing the country \$15 billion per year, almost one per cent of Canada's GDP; and
- Extreme Weather Impacts – before 1996, only three natural disasters exceeded \$500 million in damages (adjusted to 2010 dollars) but beginning in 1996, Canada had averaged one disaster almost every single year costing \$500 million or more.

They quoted a number of global estimates of Canada's infrastructure deficit – across all sectors and sub-national jurisdictions. A 2013 study by the Canadian

Chamber of Commerce estimated that the breadth of investment needed to address Canada's infrastructure deficit could be as high as \$570 billion. A recent study by the Canada West Foundation estimated the accumulated infrastructure debt at \$123 billion for existing infrastructure, with an additional \$110 billion required for new infrastructure. Finally, in a sobering report, the Association of Consulting Engineers of Canada estimates that 50 per cent of public infrastructure will reach the end of its service life by 2027.

Moreover, estimates of the effect of chronic underinvestment in infrastructure had shown that the infrastructure deficit was hindering national competitiveness. Between the mid-1990s and 2006, infrastructure investment within Canada declined, while the US increased spending by 24 per cent. During the same period, Canada went from near parity with the productivity of the US to 20 per cent lower.

"It is clear that, regardless of the exact size of Canada's infrastructure needs, the various estimates show that the problem is significant in scale and

that drastically increased levels of public investment are warranted," they said.

A National Infrastructure Plan

The authors say the need for a National Infrastructure Plan is clear and could, at minimum, include the following components:

- A comprehensive, multi-year plan that would prioritise infrastructure projects across a number of areas of national significance;
- Transparent disclosure of infrastructure planning and project prioritisation;
- Dedicated annual targets for infrastructure investment;
- A decoupling of infrastructure investment decisions from annual operating budgets;
- A detailed inventory of infrastructure needs, including maintenance and new build requirements;
- Clear, transparent rules for infrastructure funding programs;
- Accounting and budgeting provisions that recognise the multi-year nature

of infrastructure investment, including a separate Capital Budget;

- Financial tools for municipalities and public sector entities which cannot efficiently access capital markets; and
- Dedicated funding mechanisms to address the misalignment of infrastructure responsibilities with fiscal capacity.

They conclude that decades of neglect and underinvestment have left Canada on the precipice of a national crisis.

"Numerous studies and analyses have shown that Canada faces a substantial infrastructure deficit, both in terms of maintaining our existing assets, as well as servicing unmet demand for new infrastructure. This deficit extends across almost all areas of public infrastructure, including transportation and transit, water and wastewater, social and cultural institutions, affordable housing, electricity transmission, environmental and climate change adaptation and many more.

"The long decline of Federal involvement in infrastructure spending

has exacerbated the problem, as the vast majority of infrastructure inventory is in the hands of Canada's municipalities and provinces, creating a misalignment between funding responsibility and fiscal capacity within the country."

JOHN BRODHEAD is a former adviser to Hon John Godfrey, Minister for Infrastructure and Communities, and a former Deputy Chief of Staff for Policy for Ontario Premier Dalton McGuinty. He was Vice-President of Metrolinx and is now the Executive Director of Evergreen CityWorks, an initiative designed to build better urban infrastructure in Canada.

JESSE DARLING is an Urban Project Designer for Evergreen CityWorks. She has previously conducted research and policy analysis for the Martin Prosperity Institute and Harvard Graduate School of Design in urban affairs and municipal governance.

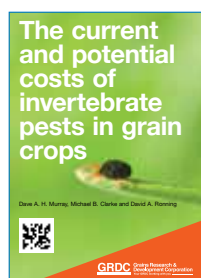
SEAN MULLIN is an economist, policy adviser and consultant, and has previously worked in senior roles at the Province of Ontario and in the asset management industry.

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Infrastructure planning is a critical issue

Melbourne's Eastlink – an iconic piece of Australian infrastructure.

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

Infrastructure – notably transport, water, energy and communications – is vital for driving productivity, underpinning prosperity and our way of life – and it impacts on all aspects of our society.

These were key points made by the Academy in its submission to the House of Representatives Standing Committee on Infrastructure and Communications Inquiry into Infrastructure Planning and Procurement.

ATSE noted that establishing robust infrastructure plans was critical – and that better infrastructure planning and investment was a major challenge for Australia and other countries.

Meeting this challenge would better equip Australia to address other demands such as raising productivity growth, dealing with demographic change, and maintaining its competitive advantage.

Referencing the March 2013 ATSE and Infrastructure Australia workshop *Infrastructure Planning: Towards Best Practice*, the Academy noted that long-term national vision and aspirations need to be better articulated to guide and direct infrastructure planning.

Governments needed to follow through on their commitments to the development of robust and integrated long-term (15 to 30-year) strategic plans for our cities, as agreed by the Council of Australian Governments (COAG) in December 2009. They also needed to deliver on their commitments to develop medium-term (5 to 15-year) prioritised infrastructure and land-use plans, so that

industry had greater confidence to invest and the community had greater certainty.

There was a need to improve the quality and consistency of project proposals that were aligned with these strategic plans and that robustly demonstrated net economic, social and environmental benefits.

Another advantage of long-term planning was that it boosted the confidence of engineering and other firms to invest in the most modern and productive equipment that needed to be amortised over several projects, over several years – for example, tunnelling machines, cranes, fabricating facilities, barges and helicopters, ATSE said.

There seemed little likelihood of investment in ship yards or wind-farm tower fabrication under the constant changing policy environment.

Australia's adversarial political system and three tiers of government made infrastructure planning difficult. There was a need to strive for bipartisan support between political parties, and tri-partisan support between levels of government. A formal consultative mechanism introduced at the earliest possible planning stage that attempted to resolve differences as quickly as possible would be welcome, ATSE said.

Current government budget processes, involving a one-year budget and three years of forward estimates, were partly why the country had struggled to establish an effective infrastructure pipeline. A coherent pipeline of projects was required that allowed industry to develop effective delivery plans and better workforce management, particularly in engineering.

Defined planning horizons linked to medium-term budgets would support the development of

appropriate project pipelines.

Like governments in Canada and the US, governments in Australia needed to present 10- year budgets and estimates of their prospective infrastructure outlays.

Efforts to improve the integration of land use and transport planning need ongoing support and momentum from governments, industry and the community, ATSE said. Reserving corridors for future infrastructure networks was vital to maintain a capacity to deliver affordable infrastructure in the future.

ATSE recommends that more focus should be placed on maintenance and high-value/low-cost projects. Outsourcing of technological input into the decision-making processes of Federal, State and local governments had led to domination of selected projects with short- term financing. This led to less-than-adequate provision for maintenance, which neglected whole-of-life costing and led to the acceptance of lowest-cost tendering irrespective of the longer-term maintenance costs.

ATSE noted that Queensland had recently developed a promising approach to addressing infrastructure challenges by developing longer-term plans.

ATSE backed the concept of cost-benefit analysis of proposed projects in a separate submission lodged with the Bureau of Infrastructure, Transport and Regional Economics relating to its Overview of Project Proposal paper – noting the need for cost-benefit analyses to capture the costs and benefits accruing from large infrastructure projects as fully as possible.

The submissions are available on the
ATSE website
(Activity/Infrastructure/Submissions)

Statement of Expectations will drive IA activities

Infrastructure Australia (IA) should be free to manage its own agenda and deliver high-quality advice on nationally significant infrastructure needs, according to the Government.

Deputy Prime Minister and Minister for Infrastructure and Regional Development Warren Truss, announcing the Government's first Statement of Expectations for IA, said the Government expected IA, under the direction of the new Board, to consult and establish productive working relationships

with key infrastructure stakeholders – including all levels of government, other relevant bodies and organisations, infrastructure owners and investors.

"The Board will keep me informed of its actions and alert me to events or issues that may impact on operations. In particular, I look forward to regular progress reports on initiatives and activities, as well as a twice-yearly report to the Ministerial Transport and Infrastructure Council," Mr Truss said.

"Through our changes, IA is

moving away from assessing lists based on previously announced government priorities to instead focus strategically on Australia's future infrastructure needs. This will inform decisions, rather than simply catch-up to decisions already made.

Mr Truss stressed that the Australian Government expected Infrastructure Australia to complete a full evidence-based audit of Australia's infrastructure asset base, in consultation with all jurisdictions.



Peter Watson FTSE, former CEO and MD of Transfield Services, is a member of the IA Board.

"Importantly, Infrastructure Australia is now undertake a comprehensive audit of northern Australia's infrastructure, while also developing a 15-year national Infrastructure Plan that identifies the infrastructure required to increase productivity and support economic growth," he said.

Infrastructure Australia will respond to the Government's Statement of Expectations with a Statement of Intent before the end of this year.

The Australian Government Review of Corporate Governance and Statutory Authorities and Office Holders (the Uhrig Review) recommended that Ministers should issue Statements of Expectations to their portfolio bodies to clearly articulate the Government's expectations of each body, while respecting areas of independence of the body in accordance with the legislation establishing it.

INLAND RAIL FREIGHT PROJECT PLANNING ADVANCES

Freight volumes between Brisbane and Melbourne are forecast to triple by 2050, based on 2010 figures, according to Australian Rail Track Corporation (ARTC) Chief Executive Officer John Fullerton.

Work was underway on the proposed Inland Rail freight project, he said, which aimed to connect key regional centres and rural producers to major ports, capitals and distribution to meet freight demand.

ARTC recently held a series of briefings on the project in Sydney and Brisbane for more than 400 representatives from Australian and international construction and rail companies, consultants and suppliers.

In a joint statement with Deputy Prime Minister and Minister for Infrastructure and Regional Development Warren Truss, Mr Fullerton said consultation with industry would continue until the end of the year, with services briefs for planning approvals, reference design, geotechnical and survey designs, as well as environmental impact assessments, expected in the first half of 2015.

"Through these briefings, industry now has greater insight into the intent, challenges and performance specifications expected from the Inland Rail project – such as the kind of axle loads, transit times, speeds and size of the trains, which will dictate the standards Inland Rail will be built to," Mr Truss said.

"They also have a better understanding of the priority elements and indicative timeframes being worked to, so industry can start their planning accordingly."

Mr Truss said the Australian Government has committed \$300 million to enable Inland Rail deliver pre-construction activities such as detailed corridor planning, environmental assessments, community consultation, and commencing land acquisition.

"The new freight link is expected to offer a competitive service to road freight as transit times between the capital cities will be under 24 hours."

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ATSE IN ACTION

IICA recognises ATSE priorities

The Federal Government's new Industry Innovation and Competitiveness Agenda (IICA) is based on four pillars: business environment; labour force; economic infrastructure; and industry policy.

It embraces a range of initiatives, a number of which ATSE has previously recommended to Government.

Many of the IICA initiatives – such as tax treatment of employee share options, streamlining acceptance of trusted international standards and risk assessments, crowd-sourced equity framework, and boosting commercial returns from research – align with theme one of ATSE's National Technology Challenges (NTCs), which focuses on linking innovation and industry.

The approaches to employee share options and improving venture finance was also recommended as part of ATSE's submission to the Entrepreneur's Infrastructure Program Discussion Paper in June 2014.

The aim to "boost commercial returns

from research" aligns directly with ATSE's recently proposed 'Impact and Engagement for Australia' (IEA) metric, which would incentivise publicly funded researchers to collaborate with business.

The Industry Growth Centres (IGCs) initiative is a central part of the IICA, and identifies five priority industry sectors in which to establish IGCs:

- Food and agribusiness;
- Mining equipment, technology and services;
- Oil, gas and energy resources;
- Medical technologies and pharmaceuticals;
- Advanced manufacturing.

These sectors align closely with several of ATSE's NTCs, respectively, themes five (agriculture and food), four (natural resources), four and three (natural resources and energy), two (health technologies) and one (advanced manufacturing).

The aim of the IGCs directly addresses ATSE's calls to improve collaboration and linkages between business and research. Another key IICA initiative is in STEM education, with funding of \$12 million. This is primarily dedicated to developing mathematics-focused

resources for primary and secondary schools. This aligns with theme seven of the NTCs (STEM education).

In addition to ATSE's NTCs, several of the proposed measures were recommended in the Securing Australia's Future Project 4 report *The role of science, research and technology in lifting Australia's productivity*. This project was chaired by Dr John Bell FTSE and managed by ATSE on behalf of the Australian Council of Learned Academies (ACOLA).

The Academy has written to the Prime Minister to congratulate the Government on releasing the IICA and adopting a number of ATSE's recommendations, but also to note the relatively small contribution towards STEM education. The President sent a personal message to Minister Macfarlane to congratulate him on his work in developing the Agenda, and to offer the Academy's support and assistance in achieving our shared objectives.

Although specific details on many of the initiatives announced in the IICA are still to be released, the Academy should be encouraged that the Government has adopted so many of the areas identified by ATSE as priorities.

ATSE looks forward to working with the Government to further develop these programs.

SCIENCE ADVISERS IN THE SPOTLIGHT

Science advisers to government – and their advice – were in the spotlight at a recent two-day conference in Auckland, attended by more than 200 delegates from 47 countries.

Organised by the International Council of Science (ICSU), an NGO with a global membership of national scientific bodies, Australia was well represented by the Chief Scientist, Professor Ian Chubb AO, and Chief Scientists (or their equivalent) from WA, NSW (Professor Mary O'Kane FTSE), Victoria (Dr Leonie Walsh FTSE), Tasmania and Queensland (Dr Geoff Garrett AO FTSE). Other Australian attendees came from the Academy of Science and CSIRO, and Dr John Bell FTSE, an ATSE Senior Adviser, represented the Academy – and provided this report.

Speakers differentiated science advice from science policy advice, with the majority taking the view that the latter was more the preserve of government departments. In some cases this was seen as 'science for policy' contrasting with 'policy for science'.

The delegate from the UK Parliamentary Office argued that science advice to parliamentarians was also important and fulfilled a different function. It was widely recognised that science is sometimes not the issue, but gets caught up in debates that reflect different political perspectives.

The need for science advisers to gain the trust of ministers was recognised as key to gaining their confidence and essential if

science advisers were to be effective. Choosing where and when to enter a public debate was a critical decision. Both formal and informal advice needed to be provided. Science advice needed to take account of different views within the science community. Science should be the voice of reason.

A number of delegates argued that science advisers should not be advocates (at least for specific science investments). Advocacy by scientists was seen as sometimes associated with self-interest and opportunistic rent-seeking.

Advisory structures and governance issues also received attention. Some science advisers have advisory councils. Others work through networks of science advisers in departments.

Problems with governments seeking science advice from individual scientists (usually academics) on an ad hoc basis were discussed, noting that it was often difficult for individuals who had little experience with government to provide advice in a form that ministers could use.

ICSU will publish a detailed report of the proceedings. Most presentations are available on a website set up by the New Zealand Chief Scientist (www.globalscienceadvice.org).

John Bell



ATSE IN ACTION

Energy Green Paper has gaps, says ATSE

The Australian Government's Energy Green Paper 2014 has weaknesses in three critical areas, according to the Academy.

In its submission to the Department of Industry, ATSE identifies its short-term focus, acceptance of fossil fuel reliance and institutional and fiscal barriers to proposed reforms as the key weaknesses.

It notes that the majority of the document is focused on resolving near-term issues but falls short in positioning Australia's energy strategy to support the significant investment that will be required in the medium to longer term.

ATSE criticises its general acceptance that Australia and the rest of the world will continue to rely on fossil fuels for several decades.

"This may be so, but failure to recognise and plan for the real geopolitical and economic risks of Australia potentially finding itself to be out of step with international thinking around greenhouse gas (GHG) emissions and climate change leaves the country exposed to possible future international moves to limit and/or price carbon emissions," ATSE says.

Finally, it notes, the Green Paper proposes a range of reforms and suggestions that appear difficult to deliver upon under present policy settings. This is due to institutional constraints, such as lack of bipartisan support or policy misalignment between the Commonwealth and States, and/or fiscal constraints – such as funding cuts to research institutes, universities and State-owned utilities and reduced profitability in the energy and resources sector.

While ATSE considers the Green Paper's goals and proposals well-focused and sound, it suggests several additional topics that the Australian Government should consider in the development of the subsequent Energy White Paper.

Energy security and reliability

The Green Paper does not adequately address the security and reliability around Australia's power systems or transport fuels, ATSE says. ATSE recommends energy policy settings that create long-term certainty for investors – a critical issue for Australia with investment in the electricity sector at very low levels despite low interest rates.

It suggests that policies be more supportive of innovation and investment in more efficient,

less emission-intensive technologies, including both renewables and nuclear energy, so that it is easier to write down and replace older, inefficient and emission-intensive fossil-fired plant and equipment.

In relation to security of gas supplies, it says three additional proposals should be considered:

- Addressing the issues that are preventing resolution of current restrictions on coal seam gas (CSG) exploration and/or hydraulic fracturing in NSW and Victoria;
- Encouraging pre-investment in gas pipeline infrastructure, which is likely to attract and accelerate investment in exploration and development of onshore, unconventional gas resources; and
- Improving community engagement – which must be preceded by increased community trust in both industry and government.

Electricity prices

ATSE agrees with the fundamental premise in the Green Paper that the present cost/price/value relationship is not effective and

We need low-emission fuels for transport

ATSE has renewed its call for accelerated progress towards sustainable mobility of people and freight by integrating low-emission fuels into Australia's transport energy mix.

In a submission to the inquiry into Australia's Transport Energy Resilience and Sustainability, by the Senate Standing Committees on Rural and Regional Affairs and Transport, says the Australian economy depends on well-developed and extensive transport networks that move people, goods and resources domestically and offshore.

It draws heavily on the *Low Emission Fuels for Transport* Action Statement supporting the ATSE Energy Position Statement, which notes that Australia has some unique characteristics:

- A heavy reliance on imported (increasingly refined) petroleum products for transport fuels and chemicals which is likely to increase. Australia is currently not meeting its treaty obligations to hold the equivalent of 90 days of net oil equivalent demand, making Australia vulnerable to disruption or misdistribution of supply;
- A highly urbanised but small population that is sparsely distributed and separated by long distances;
- Distances covered by national and international flights make secure sources of aviation fuel a priority;
- Electricity generation being primarily fossil-fuel-based, making meeting of internationally agreed emissions targets a challenge;
- Finite agricultural land and water, most of

which is needed for production of food and fibre; and

- A vibrant but under-resourced energy research, development and demonstration (RD&D) sector.

The submission reiterates the Action Statement recommendations calling for:

- Energy productivity, electrification and low carbon fuel technologies in the transport system;
- Security and diversity of transport fuel supplies;
- Production of low-emission fuels for aviation as a strategic priority;
- Regulations, incentives and market signals to improve vehicle efficiency and pollution standards; and
- Innovation to support future fuel (RD&D).

ATSE IN ACTION

supports modifications to tariff structures along with a broadening of tariff choices to better align retail electricity prices with time-of-day cost and service value.

"Australia must also position itself to be capable of meeting not just its near-term emissions reductions commitments but its longer-term conditional emissions reductions targets. The Green Paper does not address Australia's readiness in this regard at all and hence leaves the electricity sector and economy highly exposed to future electricity price increases," ATSE says.

Gas supply

ATSE says Australian governments must work together, drawing upon the best available scientific advice, to facilitate removal of the current restrictions on CSG exploration and/or hydraulic fracturing in NSW and Victoria.

Long-term support for research, development and demonstration (RD&D) and strategic incentives might also be considered in order to accelerate investment in exploration and development of certain onshore, unconventional gas resources.

Security, innovation and productivity

ATSE strongly recommends that the stated goal of *securing reliable and affordable energy in a technology neutral way that could also*



Australia must transition its energy sector to lower emissions.

*help to lower emissions must be recast as securing reliable and affordable energy in a technology neutral way that **will transition the energy sector** to lower emissions.*

It notes that in the area of innovation, the lack of policy stability in Australia for at least the past decade and uncertainties around the carbon price outlook, the future costs of different low-emissions technologies and the level of energy demand have dampened private sector investment in research and development (R&D) and particularly in the demonstration of

low-emissions technologies.

"In recent years, financial stress and staffing cuts in the electricity and much of the resources sectors, and cuts to industry and government R&D budgets means innovation and collaboration between business and universities in the energy sector is declining," ATSE says.

"The Australian Government must play a critical role in reversing this trend."

The submission is on the ATSE website

New national water reform strategy needed

The Academy has called on Australian governments to commit to a new decadal strategy for national water management reform to lock in past achievements and prepare for future challenges.

In its new position statement, **National Water Management: New Reform Challenges**, ATSE recognises the key role that leadership has played in the success of national water management reform in Australia over the past two decades through the 1994 Council of Australian Governments Water Reform Framework, and the subsequent 2004 National Water Initiative.

Despite a long-running program of internationally recognised reforms, there remains significant and complex unfinished business for national water management in

Australia. As one of the driest continents on Earth, water will always be scarce in Australia and the challenges of managing it efficiently will only increase in the future.

ATSE describes a vision of continuing water reform to enrich all Australians that will require leadership, cooperation, and commitment from all levels of Australian government, and warns that "a plan for the next decade of water reform must be prepared now".

Priority issues for a future reform agenda include:

- Urban water;
- National principles for water management in the mining and gas sectors, and in northern Australia;
- National principles and guidelines for

the development of new irrigation infrastructure, including dams;

- A national strategy and priorities for water science and research; and
- National principles for the best use of environmental water.

National Water Management: New Reform Challenges is available on the ATSE website.



ATSE IN ACTION

We need to drive health technology uptake

Australia needs to drive the uptake of assistive health technologies – to reduce healthcare costs and allow people to live more independently and stay at home longer – according to a new ACOLA report.

This will only happen with the establishment of a national network to accelerate adoption of assistive health technologies, the report says.

Assistive Health Technologies for Independent Living, released by the Australian Council of Learned Academies, says a national multidisciplinary network that focuses on users could accelerate the development and widespread use of the technologies to provide greater lifestyle choice and control to the aged, people with disability and the chronically ill.

The ACOLA report says a new national network would create an environment to bring technologies to mainstream users, based on market demand. The network could undertake the critical task of connecting research with service delivery and



Simon McKeon dons a red sterile disposable hairnet to make a point during his address.

accelerating innovation in the system.

Assistive Health Technologies for Independent Living was launched by Mr Simon McKeon AO, CSIRO Board Chairman and Chair, Strategic Review of Health and Medical Research.

Expert Working Group Co-Chair and report co-author Dr Erol Harvey FTSE said: "Many opportunities exist to capitalise on new technologies to improve quality of life, health outcomes and independent living, but new strategies are required to increase the speed of uptake and overcome the lack of

competitiveness in the Australian market.

"Technological innovation alone is not adequate. The uptake of assistive technologies will rely on multidisciplinary networks which bring together researchers, service providers, carers, housing providers and end-users in a continuous improvement framework.

"An assistive technologies network underpinned by a strategic plan could positively impact the large proportion of Australia's healthcare expenditure that is spent treating chronic illness and aged care."

Assistive Health Technologies for Independent Living makes a series of key findings:

- A market focus is critical;
- Expert 'champions' are required;
- A long-term business model is crucial; and
- New interdisciplinary players will be involved.

Assistive Health Technologies for Independent Living represents the final phase of the ACOLA program Making Interdisciplinary Research Work, which developed an evaluation framework for interdisciplinary research. *Assistive Health Technologies for Independent Living* is the pilot project through which the evaluation framework was tested.

The report was prepared for ACOLA by an Expert Working Group drawn from the medical technology, innovation, ageing and housing sectors, and supported by ATSE.

THE AGEING CHALLENGE

The *Assistive Health Technologies for Independent Living* report notes that the mounting challenge of low population growth and increasing ageing in Australia is expected to place increasing pressure on the maintenance of healthcare standards in the face of rising costs. There is growing concern about the financial sustainability of a healthcare system in which care delivery occurs in a hospital-centric setting and is subject to capacity constraints and workforce shortages. Chronic illness and aged care accounted for more than 70 per cent of Australia's \$140 billion expenditure on healthcare in 2011–12.

About 4.3 million Australians live with severe and profound disability and for a significant proportion of them the disability is such that they are unable to live alone safely. Together with the increased number of people of all ages with disability arising from disease and accidents, this has major impacts on the healthcare system and on healthcare costs.

The main target populations for application of smart technologies are people living alone with chronic health conditions, people with disability, people at high risk of falls, people living with dementia, people living in regional and remote locations, carers and family members. There is a wide variety of technology-based products that can enable independent living when coupled with modern communication systems. Further, technology has the potential to allow for greater social engagement, which has been shown to be an essential feature of healthy ageing.

Assistive technologies are any devices or systems that provide assistance with everyday living – ranging from simple devices such as motion sensors to devices developed using sophisticated technologies such as nanotechnology, biotechnology, information and communications technologies, and advanced manufacturing.

The *Assistive Health Technologies for Independent Living* report is at www.acola.org.au

ATSE IN ACTION

'Smart grids' hold key to electricity supply

Intelligent electricity networks – 'smart grids' – backed by enabling policy frameworks could provide Australians with efficient, affordable and low-emission electricity.

A 2013 study estimated that smart grid technologies in Australia could deliver a net economic benefit of \$28 billion over the next 20 years – but would require an integrated approach involving cost-reflective pricing, consumer behaviour change and energy market reform.

Australia's geography made it critical for smart grids to be used to encourage the investment required in energy-generating facilities to maintain reliability and quality of electricity supply.

These are key points made in a new Energy Action Statement, *Intelligent Electricity Networks for the Future*, developed by ATSE to guide energy policy development.

The Academy says that advances in technology and government policy interventions have changed the national electricity supply network from a limited number of large power generators to a more distributed system comprising more numerous, smaller and technologically diverse sources of electricity.

The role of the grid has evolved from networks for one-way power distribution to networks for two-way exchange of electricity between various participants.

Changes in energy storage requirements and the development of consumers – from passive users of electricity to individuals or groups more actively engaged with the electricity supply system through self-generation and demand management

activities – have been key elements.

The Academy recommends three key steps to enable Australia to transition to smart grids:

- Government and industry should develop a strategic blueprint for the transition;
- Government should review market rules and regulatory processes to address barriers to intelligent networks; and
- Industry and governments should jointly establish a strategic policy agenda that supports the evolutionary path to intelligent network configurations.

It notes the electricity network is increasingly required to manage more complex interactions between participants and facilities to maintain reliability of electricity supply and minimise energy cost. These include changes in the nature of production/exchange/use interactions, as well as changing production and demand characteristics resulting from the expansion of renewable and distributed generation.

This implies a need to acquire, store and use large sets of data to model a more complex network and predict its operation increasingly in real time. The developments seen in information and communication technology have provided the basis for the evolution of more intelligent and increasingly self-managing networks.

This is particularly critical for Australian electricity networks as new investment in facilities to maintain reliability and quality of supply will be impacted by new configurations of network supply and use facilities – thus requiring flexible approaches to provide the capacity needed for reliable supply.

The Academy says transition to intelligent networks will be a long-term process, requiring strategic development of technology and

Time for smart grids.

underpinning strategic policy development, strategic changes to market structures and significant investment, but – if done effectively – will play a key role in minimising the investment needed to provide efficient, affordable and low-emission power for the Australian economy.

The Action Statement forms a key part of ATSE's submission to the Federal Government's Energy Green Paper. ATSE's submission covers energy security, electricity prices, building gas supply and increasing energy productivity. It criticises the Green Paper for lacking a long-term vision, failing to account for climate change, and a series of institutional and fiscal barriers to implementing the reforms suggested. ATSE views intelligent energy networks as an important component to increasing Australia's energy productivity.

Intelligent Electricity Networks for the Future is on the ATSE website.

KEY CHARACTERISTICS OF SMART GRID SYSTEMS

- A range of consumer interface types – from simple energy metering through a more complex interface to facilitate energy interchange, access to storage, and demand management options. No single element can handle the diverse consumer requirements.
- A more complex real-time information-based protection system for the networks to manage the impact of changing power flows through the network resulting from unforeseen changes in power production.
- A network management system capable of handling less schedulable demand, increased interaction between electricity suppliers and users, and more distributed systems in which production and use are increasingly co-located.
- A more dynamic systems management structure to maintain system integrity in the face of uncertainties.
- Market signals that provide an appropriate balance between risk, cost impacts and rewards.

ATSE IN ACTION

The future of work: reinventing industry

Powerful, deep and far-reaching transformation is underway across industry, across Australia, across the globe. It is fundamentally changing the way we design and manufacture products, and what these products can do.

It is making the complex supply chain and distribution networks that tie the global economy together faster, more flexible and more resilient.

It is redefining the competitive landscape in multiple sectors. And it is affecting each of our daily lives through major advances in healthcare, energy, transportation and the way we work.

This transformation is the Future of Work – and was the theme of an address to the NSW Division Manufacturing Luncheon Series in Sydney in October by Mr Steve Sargent FTSE, President and Chief Executive Officer of GE Mining.

Addressing an audience of 70, Mr Sargent said we were living in one of the most exciting times in history.

“We are experiencing change at a greater pace and of a greater magnitude than at any time before,” he said.

“During the Industrial Revolution we saw ‘muscle power’ be replaced by ‘steam-and-electrical-driven-machine-power’. Today, we see a similar picture where ‘brain power’ is being augmented by ‘digital technology power’... which is resulting in the creation of new industries and new jobs almost on a weekly basis.

“Mankind has never seen this pace of change before.”

His key points included:

- Governments play a major role – they need to attract companies and innovation to our shores through attractive policies and highly skilled workforce. Economic power shifts can happen quickly.
- Rapid technological change is being driven by the proliferation of personal computers connected through the Internet allowing digital content, ideas and knowledge to be exchanged at virtually no cost. Workflow software enables people around the

world to collaborate and author ideas simultaneously.

- The pace of technological change is accelerated through mobile, connected computing power and low-cost sensors, cloud computing and advanced analytics of massive quantities of data (‘big data’).
- Industry is being reinvented. Modern locomotives have 1400 sensors that provide real-time data to optimise performance and maintenance. The 2000 sensors on aircraft engines generate 5000 data points every second, or one terabyte a day. This massive volume of data demands sophisticated computing and analysis to turn diagnostic data into prognostic information used for maintenance scheduling.
- Worldwide, a one per cent decrease in maintenance costs translates to a saving of \$30 billion a year.

He noted that GE had experimented with start-up strategies including crowd-sourced product designs.

“Open-source innovation” described the

DSTO a key to our defence capabilities

Robust capability in science, technology and engineering has historically underpinned the ability of the Australian Defence Force to maintain technological superiority over other countries in our region, along with our ability to operate effectively with our key allies.

If these strategic advantages are to be maintained, it is critical that a strong focus be given to science, technology and engineering, both specific to defence and security and in a broader sense, the Academy says in its submission to the 2015 Defence White Paper and First Principles Review.

ATSE’s submission focused on two key aspects:

- The pivotal role of the Defence Science and Technology Organisation (DSTO) in employing science and technological innovation for competitiveness and

comparative advantage; and

- The critical need to enhance Australia’s capacity in science, technology, engineering and mathematics (STEM) to provide the workforce capable of designing, building and maintaining Australia’s defence materiel.

ATSE said DSTO was an effective model for conducting defence research, responding to the ‘market-pull’ needs of the Australian Defence Force, and its privatisation, or ‘outsourcing’, as proposed by the National Commission of Audit, would be counterproductive.

Whether Australia ‘bought or built’ to meet its sometimes unique defence requirements, it needed the ability to test, modify and deploy in an increasingly technological environment, which DSTO provided. Adapting Australia’s defence needs in response to deployments such

as Afghanistan was crucially important. DSTO was the first-choice evaluator, providing an integrated, embedded capability, ATSE said.

To maintain Defence’s heavy reliance on technology, Australia needed to invest not only in research but also in structures that integrated science, research, technology and innovation into the nation’s Defence establishment, ATSE said.

Central to this integrated structure was continued support for DSTO and programs that supplied qualified engineers and technologists to the ranks of Defence and defence contractors.

Lifting Australia’s industrial and business productivity through research, innovation and collaboration must be a key priority to enhance Australia’s competitiveness and to ensure its comparative advantage, ATSE said, noting the

ATSE IN ACTION

THE INDUSTRIAL INTERNET

Currently turbines on wind farms communicate with each other, exchanging information on wind speed and turbine performance, in a process called real-time analytics. Turbines inform technicians when maintenance is required, and turn themselves off before they fail, resulting in a 10 per cent increase in productivity. The integration of complex physical machinery with networked sensors and software to adjust operations is referred to as "the industrial internet", which connects minds and machines and can translate to zero downtime and greater productivity.



Steve Sargent

process of firms accessing external ideas to complement those generated internally, he said.

He cited – to illustrate the power of innovation in a hyper-connected world – the example of a jet engine bracket, where a \$50,000 prize inspired a dentist in Singapore to design a new bracket made of titanium alloy on a 3-D printer (additive manufacturing), which was one-tenth the weight of the existing bracket.

Mr Sargent noted that the 'future of manufacturing' – resting on the rapid convergence of the physical and digital worlds, combined with agile manufacturing and evolutionary ecosystems – was at once disruptive and unstoppable.

Machines as complex as aircraft could be designed on a computer, tested on a computer and manufactured using computers, with only the final stage requiring physical construction and validation.

The combination of virtual design and manufacturing, smart factories and supply chain optimisation improved cycle time by a factor of two to four, doubled yield, halved downtime and vastly improved predictability and business performance.

He said human capital was being transformed. Relatively low-tech unskilled jobs were being rapidly automated, and highly skilled people were being augmented by the digital world. The message for future

employment is clear – investment in STEM (science, technology, engineering and maths) was essential, as future jobs would be driven by innovation and quality education.

Mr Steve Sargent FTSE was the first Australian to be appointed to GE's executive and is chairing the B20 Human Capital Taskforce during Australia's Presidency of the G20. He has held business leadership positions in the US, Europe and Asia for GE. He is a Director of the Business Council of Australia, and formerly a member of the Treasurer's Financial Services Advisory Council and President of the American Chamber of Commerce in Australia. He joined the Academy in 2013.

– Contributed by Brian Spies FTSE

Government had recently acknowledged this priority through its Industry Innovation and Competitiveness Agenda (IICA).

There were many parallels between the importance of innovation to the wider Australian economy and to defence. Although Australia would always be a net importer of technology, both in defence and in general, ATSE said it believed it was essential to maintain a strong indigenous innovation capacity to ensure that its innovations could be used to meet its national needs and not be completely reliant upon overseas suppliers.

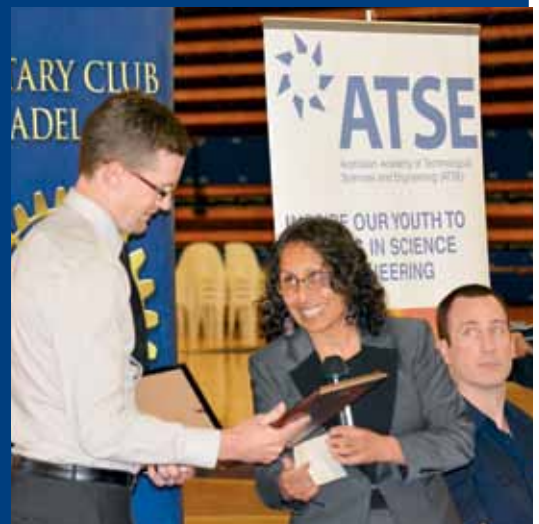
Similarly, Australia's defence ecosystem, both within and external to government, must have access to and utilise technology and innovation to its fullest extent.

The submission is on the ATSE website

EXCEPTIONAL CONTRIBUTION WINS 2014 SA TEACHER AWARD

SA Division Chair, Dr Meera Verma FTSE, presented the ATSE 2014 SA Teacher's Award to Mr Jeremy Le Cornu of Brighton Secondary School during the finals of the South Australian Science and Engineering Challenge in Adelaide in September. The award recognised his exceptional contribution to teaching and learning through the use of ICT, first at Henley High School and also at Brighton Secondary School, where he holds the position of Coordinator of Teaching and Learning in a Digital World. The Award comprises a plaque for the teacher and a cheque for the school of \$2000.

Meera Verma presents the award to Jeremy Le Cornu.



More Fresh Science/

A dozen young Australian scientists competed in the finals of the 2014 FameLab Australia award, previously known as the Fresh Science Awards. We covered some of their work in the last edition of *Focus*. Here is the research of another four. Fresh Science is a national competition that has been helping early-career researchers publicly share their stories of discovery for the past 12 years. In 2014 Fresh Science partnered with the British Council to present the inaugural FameLab Australia.

WORM SPIT HEALS THEN KILLS

Cairns researchers have discovered a wound-healing and cancer-causing hormone in the spit of a liver worm that lives in more than nine million people and infects adventurous Australian tourists.

Michael Smout



The South-East Asian liver fluke munches through the liver, repairing the damage as it goes. But after many years of infection it can cause liver cancer. It kills 20,000 people each year in Thailand alone.

James Cook University (JCU)

researcher Dr Michael Smout has found that a protein in the spit also sends wound-healing messages.

In 2010 JCU researchers discovered that the worm spit was promoting cell growth and wound repair. Then in 2012 Dr Smout discovered a growth hormone in the spit, showed it was responsible both for the repair and in part for the cancer, and that it promotes wound-healing. He hopes that the work will lead both to new wound-healing compounds and to a vaccine against the worm.

Dr Smout presented the work publicly for the first time at FameLab Australia 2014 and won the Australian final.

The discovery is part of a long-term JCU effort to understand and fight the fluke and other parasites led by Professor Alex Loukas. Just how the hormone stimulates wound-healing remains unknown, but the team thinks that the healing action of the worm spit helps limit the damage it causes to its human host, allowing both to live longer.

"We hope that our research will lead to vaccines to prevent cancer in impoverished regions of Asia, and to new treatments for non-healing wounds, which are an increasing problem for smokers, diabetics and an aging population here in Australia," Dr Smout says.

MIRROR MOTION MAGNIFIES LASER SENSOR VIBRATIONS

Dr Francis Torres, a physicist at The University of Western Australia, has developed the mirror device at the heart of a new amplifier technology, which uses an interaction between a high-powered laser and mirror motion to magnify subtle metal, temperature and biological vibrations so they are more easily detected.

"Our idea is to connect the sensors in existing space exploration tools to our amplifier so they can look deeper underground and find smaller and hard-to-find targets such as hidden mineral deposits, water or other bacterial life," says Francis, who developed the resonator mirror as part of his PhD.

According to Francis, the amplifier technology could also enhance the detection sensitivity of Earth exploration tools and medical sensors.

The sensors of existing exploration tools vibrate when they detect something in the ground, but if the object is too small or too deep, the vibration may be too subtle for the exploration tool to read/measure.

The amplifier technology works by attaching the sensor of an

existing exploration tool to the back of the resonator mirror. When the sensor picks up a subtle vibration, it makes the resonator mirror vibrate as well. These vibrations then interact with the amplifier's laser and two ordinary mirrors to increase the resonator's vibrations so that the exploration tool can more easily read them.

Francis Torres



FameLab winners



Lisa Schafrank

CANCER EATS ITSELF TO BEAT TREATMENT

Stubborn cancer cells play a cunning trick when faced with treatments designed to kill them – they eat themselves to survive. But South Australian Health and Medical Research Institute (SAHMRI) researchers have found a way to starve the cancer cells, making them more susceptible to cancer therapy.

As researchers develop more personalised cancer therapies that target cancer cells, they are also seeing an increase in resistance to treatment, where patients relapse or no longer respond to treatment.

One way that cancer resists treatment is by undergoing a process where the cancer cells eat themselves to maintain energy levels during times of stress – a process that helps them survive cancer treatments that would otherwise starve them.

Lisa Schafrank, a University of Adelaide PhD student working at SAHMRI, and her colleagues have used a clinically available drug to stop leukaemia cells from eating themselves to survive cancer therapy.

"We've managed to block the self-eating process at a stage where the cell would normally break down its food into energy," Lisa says. "The cell still eats itself, but it can't transform that food into anything useful. So in the end, the cell essentially starves by eating itself to death. By preventing the cancer cells from self-eating, we're cutting off their escape route and forcing them to face the cancer therapy."

Their treatment uses a clinically available drug, which was originally developed as an antibiotic to treat lung infections.

This work provides a way of making current cancer treatments more effective and less likely to leave behind surviving cancer cells that might re-grow and cause a patient to relapse, or force the patient to stay on cancer treatments for the rest of their life.

MORE 'ARMS' THE KEY TO STRONGER CARBON FIBRE

Lighter-weight, fuel-efficient cars may be closer to reality thanks to Geelong researchers who are giving carbon fibre the gripping power it needs to be able to stand up to impacts from motorists.

High-performance vehicles already use carbon fibre – a high-strength, lightweight material that can be moulded into complex shapes – to make cars lighter, more fuel-efficient and faster.

But although strong, carbon fibre is prone to damage from sudden impact. And unlike metal, it can't be repaired – only replaced.

This factor has limited the material's uptake by the wider automotive industry, as the common bingle would end up costing motorists a lot more to fix.

Ms Linden Servinis, a PhD student at Deakin University, and her colleagues have developed a treatment for carbon fibre that makes it 16 per cent stronger by forming extra chemical 'arms' that grip onto its surroundings, allowing the material to withstand greater impacts.

By creating a less damage-prone material, Linden hopes to increase the likelihood of wider carbon fibre uptake by the automotive industry.

Their research also shines light on further possibilities for altering

Linden Servinis



a range of carbon fibre surfaces. Increasingly used in aerospace, high-performance automotive, sporting, and oil and gas industries, carbon fibre materials are replacing traditional materials such as steel and aluminium.

WOMEN IN TSE

Women win variety of research grants

Women academics were prominent in the recent round of ARC grants, announced by Education Minister Christopher Pyne, which allocated \$354 million to 941 new research projects across Australia as part of the 2015 ARC major grants.

Grants that feature women researchers in science and technology fields include:

QUT, Lead Chief Investigator **Professor Lyn English** (\$603,900) – this project aims to introduce a new approach to improving the nation's skills in science, technology, engineering, and mathematics (STEM) learning across Grades 3 to 6 through modelling with data. With a focus on inquiry processes involving data variation and uncertainty within STEM-based contexts, the project aims to develop the important mathematical and statistical literacies needed for lifting student achievements.

QUT, Lead Chief Investigator **Dr Kathryn Fairfull-Smith** (\$445,300) – this project aims to develop new chemical approaches to deliver nitroxides at surface interfaces and in microparticles to facilitate long-term control over biofilm growth, acknowledging that bacterial biofilms are a major problem in healthcare systems around the world. The project aims to reduce infection rates associated with medical devices and improve airway clearance in cystic fibrosis patients.

ANU, Lead Chief Investigator **Professor Michelle Coote** (\$409,500) – this project aims to develop new ways to minimise defect structures and thereby improve the thermal and photostability of polymers, given that radical polymerisation is the most commercially important polymer process, but its use in the synthesis of 'smart materials' for biomedical applications, molecular electronics and high-performance engineering applications has been hampered by the lack of microstructural control.

Monash University, Lead Chief Investigator **Professor Jean Armstrong** (\$384,700) – this project aims to develop a theory – efficient white light emitting diodes (LEDs) provide an opportunity to develop a positioning system for indoor applications – by using LEDs to transmit signals and create the accurate indoor positioning systems of the future.

University of Tasmania, Lead Chief Investigator **Dr Anya Reading** (\$368,200) – this project aims to improve understanding of the severe ocean storms that impact Australia, using multiple decades of the background 'noise', recorded continuously by earthquake seismic observatories, to locate and analyse ocean storms through time and identify changes in storm tracks – resulting in significant advancement in our knowledge of severe storms.

Macquarie University, Lead Chief Investigator **Dr Melanie Bishop** (\$347,900) – a project that aims to test whether the flow of beneficial genes from farmed oysters into wild oysters can make natural oyster beds and the ecological communities they support more resilient to environmental change. This project aims to develop novel genetic strategies to future-proof oysters. Thus, the outcome of this project has potential to benefit entire ecosystems that depend upon oysters.

University of Sydney, Lead Chief Investigator **Dr Lorraine Smith** (\$325,877) – a project investigating how chronic condition healthcare self-management goals are negotiated and enacted, to provide essential understanding of the mismatch between experts and patients.

The project aims to contribute new knowledge about the complex interactions between individuals and healthcare providers and is expected to result in a way forward for more effective chronic condition self-management.

Murdoch University, Lead Chief Investigator **Professor Simone Volet** (\$300,900) – this project tackles Australia's challenges in regard to scientific literacy and growth of student enrolments in science. It will examine the interplay of cognitive, metacognitive and emotional processes in future primary teachers' engagement in collaborative inquiry-based science activities, aiming to improve the quality of primary teachers' preparation for inquiry-based science.

University of Melbourne, Lead Chief Investigator **Dr Caroline Bardini** (\$206,900) – this project seeks innovative reasons for low progression rates of students in mathematical sciences subjects in Australia. It will examine students' symbol use at university and explore how it differs from the use at school. It will also examine links between students' response to increased symbolic load and their confidence to continue studying subjects with high mathematical content at university.

ALCHEMIA CSO WINS TELSTRA AWARD

Alchemia Chief Scientific Officer **Dr Tracey Brown** has been named Telstra's Victorian Business Woman of the Year.

Dr Brown, inventor of Alchemia's HyACT cancer drug delivery platform, also won the Telstra Private and Corporate Sector Award and will now go into the running to also be named National Australian Business Woman of the Year. The winner was announced in late November.

FOUR WIN MCA SCHOLARSHIPS

The Minerals Council of Australia, in conjunction with BHP Billiton and Downer Mining, has awarded four scholarships to women for studies to help them progress towards company board positions.

The scholarships, valued at \$9200 each, have been awarded to women working in the mining industry to enable them to complete the Australian Institute of Company Directors (AICD) Company Directors' Course during 2015.

The scholarship winners are:

- Lynn Olssen, General Manager Geosciences, Snowden Group (sponsored by BHP Billiton);
- Maria Zappala, Manager Business Improvement Australia and Canada, Anglo American Coal;
- Mary-Anne Crawford, Group Manager Approvals, Centennial Coal Company; and
- Michelle Elvy, Manager Production Processing, BHP Billiton Mitsui Coal (sponsored by Downer Mining).

The scholarships are an MCA initiative to encourage more female participation on mining company boards. The 2015 scholarships further the success of a program which has seen seven women complete the Company Directors' Course in 2013 and 2014.

WOMEN IN TSE

Pip Job



Grazier wins Rural Women's Award

Pip Job, a NSW grazier, environmental advocate and CEO of her local Landcare group has won the 2014 Rural Women's Award, run by the Rural Industries R&D Corporation.

Jackie Jarvis, a primary producer from WA was national runner-up.

Pip received a \$10,000 bursary as part of the NSW State Award earlier this year, which will allow her to undertake a study tour and develop a training program for women aimed at developing ways to manage the challenges of rural life. This program will increase the capacity of rural women to manage climate change and finance in a complex economy, as well as increase their personal resilience using a social, ecological and economic platform.

As the national winner, Pip will receive an additional \$10,000 bursary to enable her to develop her leadership skills and participate in speaking engagements where she can share her passion for up-skilling, motivating and building the networks of Australia's rural women.

Jackie jointly owns a commercial vineyard and wine production company and through her work with the Chamber of Commerce WA assists with strategies for workforce recruitment, retention and planning for the agricultural sector.

As the pre-eminent award for rural women in Australia, the RIRDC Rural Women's Award identifies and supports emerging leaders who have the capability and resources to drive innovation, productivity and sustainability within primary industries and rural communities.

Jackie Jarvis



OYSTERS WIN STACEY NUFFIELD HONOURS

Stacey Loftus, from Wonboyn Lake, NSW, has been awarded a Nuffield Scholarship, supported by the Fisheries Research and Development Corporation, to study marketing and branding in oyster production.

Stacey is business manager for the family oyster farm, one of the largest oyster producers in Wonboyn, farming nine leases over 13 hectares, and producing close to 30,000-dozen oysters annually for the domestic market.

Her main roles in the business are marketing, establishing new relationships with stakeholders, accounting, coordination of staff and managing harvest and stock movement records.

Stacey, the only woman among 10 Nuffield scholarship winners named for 2015, says historically the Sydney rock oyster industry has not branded or marketed itself well, a situation she wants to change.

"Oyster farming has not been an environmentally friendly industry, with the use of tar and wooden sticks and rails creating pollution and shell bed problems," she says. "We are moving into a more environmentally responsible age, by using plastics that don't break down, are often recycled, and always very costly – we now need to use these new sustainable standards to market ourselves."

Stacey wants to investigate how oyster farmers around the world have successfully used branding. She will travel to the US, France, Ireland, Japan and Singapore to complete her research.

Nuffield Australia provides annual agricultural research scholarships for selected Australian farmers to travel overseas for 16 weeks.



Stacey Loftus

BERYL WILSON SCHOLARSHIP

Nominations for the 2015 Beryl Wilson Austrade Scholarship for Women in International Business close 14 December. The scholarship honours Australia's first female Trade Commissioner, Beryl Wilson, and was established in 2013 to mark the 50th anniversary of her appointment.

Women are now responsible for leading Australia's trade diplomacy at many of Austrade's overseas offices including Kuala Lumpur, New Delhi, Washington, Tokyo, Moscow, Osaka, Toronto, Milan and Guangzhou.

To be eligible for the scholarship, women must be Australian citizens and enrolled full-time in the final year of a master's degree in international business or a master of business administration with an international business specialisation. They must also have Asian language competency. Austrade will award one scholarship in 2015 valued at up to \$40,000, covering course fees, study materials and other, related expenses.

The scholarship recipient will also participate in the Women in Global Business Program, a joint Australian, State and Territory government initiative, which aims to increase the number of women in international business.



Cowpeas are a staple food and an important source of protein for more than 200 million people in sub-Saharan Africa.

Professor Edye says. "What's most exciting is that our lignin barrier coating is sustainable – traditional wax coatings are made from petrochemicals and, once it's on the paper or cardboard, that paper or cardboard can no longer be recycled.

"We've proven that our lignin coating is cost-comparable, is 100 per cent recyclable, provides a high level of waterproofing and strengthens the boxes to a higher degree than wax – not bad for a product made from a renewable resource."

Professor Edye says about 400,000 tonnes of wax-coated cardboard are added to landfill in Australia every year because it cannot be recycled.

CSIRO goes to Africa with Gates' \$14M

CSIRO has received a \$14.5 million grant from the Bill & Melinda Gates Foundation to improve the productivity and incomes of smallholder farmers across Sub-Saharan Africa.

This five-year humanitarian project will develop tools to generate self-reproducing hybrid cowpea and sorghum crops to help millions of farmers become more self-sufficient through higher yielding crops.

CSIRO will use the grant to partner with other world-leading research teams from Switzerland, the US, Germany and Mexico to achieve this goal.

The creation of self-reproducing hybrid cowpea and sorghum crops would allow smallholder farmers to self-harvest high-quality seed to provide a more secure food supply and potentially increase income through the sale of surplus harvest and seed.

The initial stage of the project – laboratory-based – will be devoted to developing the techniques to enable cowpea and sorghum plants to reproduce asexually. If this stage is successful, later phases will bring African breeders and institutes into the project.

WATERPROOFING COATING TICKS THE (FRUIT) BOXES

QUT researchers have developed a new waterproof coating for boxes that is both recyclable and renewable.

Albert Tietz and Adjunct Associate Professor Les Edye's lignin-based coating is currently being trialled on banana boxes in North Queensland. If successful, they anticipate the product will be on the market in mid-2015.

Professor Edye says lignin is a naturally occurring byproduct of pulped wood and grasses, and the trial material was extracted from commercially grown and processed grasses.

"We discovered the potential of lignin as a waterproof coating while researching ways to add value to bagasse in the sugar industry,"



NEW FOOD INDUSTRY FOCUS AT UQ

A new ARC research training centre dedicated to creating healthier foods and preparing Australia for a surge in Asian market demand is now operating at The University of Queensland.

'Agents of change: transforming the food industry for Australia, Asia and beyond' has been awarded \$2.7 million over three years from the ARC with the aim of ensuring Australia is prepared for the challenge to create and market healthier foods and to respond to a surging demand from Asia's expanding markets.

The centre will focus on training a cohort of innovative scientists who will facilitate the transformation of the Australian food industry.

Led by UQ, the centre will combine the expertise of principal partner, the Australian Food and Grocery Council, as well as collaborating partners the International Rice Research Institute, the Rural Industries R&D Corporation, Wuhan University and Huazhong University of Science.

NEW USES FOR WINERY WASTE

Researchers at Swinburne University of Technology have developed a technique for converting winery waste into compounds that could have potential value as biofuels or medicines.

Australia, the world's sixth largest wine producer, crushes about 1.75 million tonnes of grapes for wine a year. After the final pressing, a large volume of biomass waste comprising grape skin, pulp, stalks and seeds remains. Unlike other agricultural byproducts this waste has limited use as animal feed due to its poor nutrient value and digestibility and is unsuitable for compost because it doesn't degrade.

As part of his PhD research, Swinburne student Avinash Karpe is investigating how to break down this material composed of cellulose, pectins and lignins into simpler compounds that can be used to create ethanol or other biofuels.

"Various fungi are known to degrade this waste by generating an array of enzymes," Mr Karpe says. "These enzymes convert the waste to soluble sugars, which can then be converted into other products."

Using a 'cocktail' of four fungi in a one-litre bioreactor, Mr Karpe succeeded in breaking down the biomass, increasing enzyme activity and lignin degradation.

This fermentation process takes one to three weeks and produces alcohols, acids and simple sugars of industrial and medicinal interest.

WOMEN IN TSE



(From left) Dr Se-Moon Park, WiN Global President, Margaret Elcombe and Adi Paterson.

ANSTO pioneer wins WiN Global Award

Dr Margaret Elcombe of the Australian Nuclear Science and Technology Organisation (ANSTO) has been announced the first Australian winner of the prestigious annual international Women in Nuclear (WiN) Global Award.

Dr Elcombe is a world-leading pioneer in the design, development, building and operation of neutron-scattering instruments, which are used to measure and test material composition of common objects from food particles to long-life batteries, railway tracks and aircraft wings.

For 41 years Dr Elcombe has worked at ANSTO, using neutron scattering and X-ray techniques to solve complex challenges across Australian industry. The tools that she uses at ANSTO are used to assist everything from the mining, aviation, railways, infrastructure and construction sectors.

Despite officially entering retirement in 2008, Dr Elcombe continues her work in the field, regularly visiting ANSTO's Beragg Institute and publishing as recently as this year.

"I simply consider myself a random human particle in the box of life who hasn't yet decayed," said Dr Elcombe. "I'm taken aback to have been chosen from a group of such brilliant women in this field. Without everyone at ANSTO I certainly would not have received this award."

ANSTO Chief Executive Officer, Dr Adi Paterson FTSE, praised Dr Elcombe's commitment to her field and to nurturing Australia's upcoming science leaders.

"As a pioneer of nuclear science, Dr Elcombe commands the highest international standing, and this award is much deserved," Dr Paterson said. "She probably wouldn't like me saying this, however I believe Dr Elcombe is a true role model to all scientists at ANSTO and across Australia. She has nurtured the careers of countless students, and is a true inspiration for all young women and men in science both here in Australia and internationally."

Technology leader to head CSIRO

Dr Larry Marshall, Managing Director of Southern Cross Venture Partners, will join CSIRO in January 2015 as CEO, replacing Dr Megan Clark FTSE, who has held the role for six years.

Southern Cross Venture Partners is an early stage venture capital firm specialising in creating Australian technology companies and growing them globally in Asia and the US.

Dr Marshall was educated at Macquarie University, where he took a doctorate in physics. He began his career in the Defence Science and Technology Organisation and has 25 years' experience as an international technology entrepreneur and holds 20 patents protecting commercial products. He has founded six successful US companies in biotechnology, photonics, telecommunications and semiconductors.

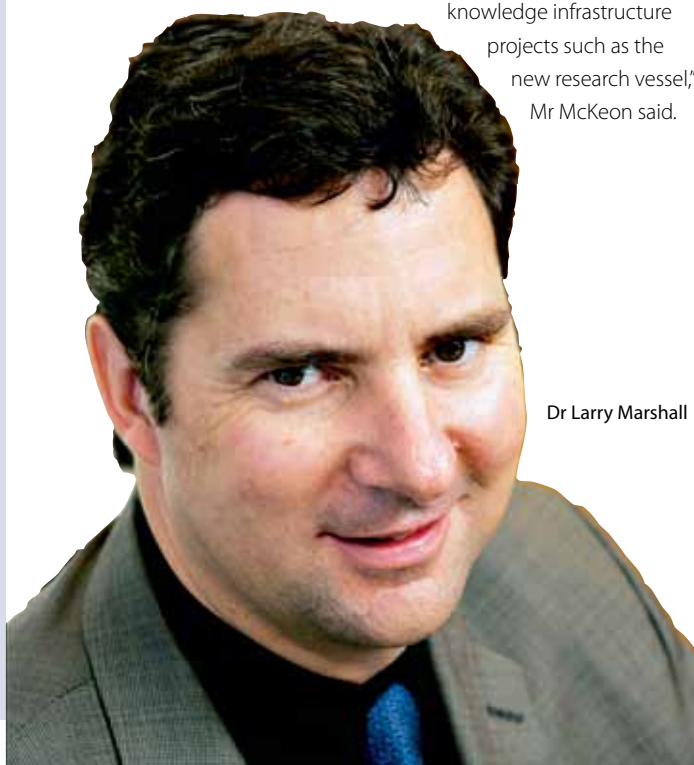
"Dr Marshall has an impeccable record as a scientist, a technology innovator and business leader," the Chairman of the CSIRO Board, Mr Simon McKeon, said. "His wealth of experience in developing and applying science and technology makes him an excellent fit."

The Chief Executive of CSIRO is probably the most important position in national science administration, Mr McKeon said. "So we conducted an extensive global search for an innovative scientist with strong business leadership qualities, and more than 70 candidates were considered."

"The Board is confident that Dr Marshall will lead CSIRO in a manner which ensures that it continues to provide advice of the highest quality to Government as well as provide best practice collaboration with the private sector."

Mr McKeon also thanked current Dr Clark for her leadership of CSIRO for the past six years. Dr Clark will leave CSIRO at the end of December this year.

"Dr Clark leaves CSIRO with a legacy to be proud of, most notably for her long-term commitment to the global competitiveness of Australian science through the establishment of research precincts; and to major knowledge infrastructure projects such as the new research vessel," Mr McKeon said.



Dr Larry Marshall

Rainforest plant may cure tumours

Scientists at QIMR Berghofer Medical Research Institute have used an experimental drug produced from the seeds of a rainforest plant to cure solid cancer tumours in pre-clinical trials.

The study led by Dr Glen Boyle at QIMR Berghofer's Cancer Drug Mechanisms group found a single injection of the drug, EBC-46, led to rapid breakdown of tumours in a range of human tumour models.

EBC-46 is a compound extracted from the fruit of the Blushwood tree from north Queensland rainforests. EBC-46 was discovered by the Queensland biotechnology company EcoBiotics and is being developed as a human and veterinary pharmaceutical through EcoBiotics' subsidiary company QBiotics.

Dr Boyle says the findings of the pre-clinical trials at QIMR Berghofer suggest the drug could be effective in human patients.

"We were able to achieve very strong results injecting EBC-46 directly into melanoma models, as well as cancers of the head, neck and colon," Dr Boyle says. "In most cases the single injection treatment caused the loss of viability of cancer cells within four hours, and ultimately destroyed the tumours."

Dr Boyle says EBC-46 works in part by triggering a cellular response that cuts off the blood supply to the tumour. "In more than 70 per cent of pre-clinical cases, the response and cure was long-term and enduring, with very little relapse over a period of 12 months."

The experimental drug has been used by veterinarians to successfully destroy or shrink tumours in dogs, cats and horses. QBiotics is currently conducting formal veterinary clinical trials with EBC-46 in Australia and the US and awaiting regulatory approval for a human phase I clinical trial.

Dr Boyle says QIMR Berghofer is keen to pursue further research to determine if EBC-46 could be made more effective. "We must stress at this point that EBC-46 will only be trialled in the short term for tumours that can be accessed by direct injection or topical application. There is no evidence suggesting EBC-46 would be effective against metastatic cancers."



Blushwood seeds – the source of EBC-46.

CONTAMINATED SITE FRAMEWORK

A new national framework for remediating contaminated sites is being developed by the CRC for Contamination Assessment and Remediation of the Environment (CRC CARE), state and federal governments, environmental authorities and clean-up industries.

The new framework will complement the National Environment

Protection Measure (NEPM) that assesses site contamination, and will help identify the best ways to clean up the nation's polluted land.

It will encourage every state to meet minimum clean-up requirements, allowing all Australians access to clean groundwater and clean land, says Dr Bruce Kennedy, Executive Policy Adviser at CRC CARE.

The new framework – expected to be completed in 2016 – will include guidelines on developing remediation plans, such as how to:

- Choose the best and most cost-effective contaminant treatment method;
- Protect clean-up workers;
- Address the concerns of neighbours during clean-ups;
- Document the entire clean-up process for future reference; and
- Validate and monitor the site after remediation.

ANSTO LINKS WITH KOREA

The Australian Nuclear Science and Technology Organisation has signed a new Memorandum of Understanding with the Korean Atomic Energy Research Institute (KAERI), updating the previous MoU signed in 1990.

The new MoU, signed in Chicago, provides scope for collaboration in research reactor utilisation and operation, radiopharmaceutical production and any other mutually beneficial activities that may arise in the future.

ANSTO, a statutory body of the Australian Government formed in 1987 to replace the Australian Atomic Energy Commission, says its international linkages with research collaborators, commercial partners and industrial innovators ensure that it remains at the forefront of efforts to address some of the most complex challenges facing the global community.

ANSTO is moving towards becoming a major global supplier of Mo-99, used to manufacture technetium-99m, the most widely used isotope in nuclear medicine. As the ANSTO Nuclear Medicine Project develops it sees linkages with key partners becoming even more important.

ANSTO is also strengthening ties with South Korea through education and exchange programs. ANSTO's Discovery Centre recently linked with primary school students in Busan, Korea. The international video hook-up allowed the students to speak to education officers and three Korean interns studying at ANSTO, and to conduct virtual experiments, measuring the radioactivity of samples in Sydney from their classrooms.

ANSTO's three Korean interns are furthering their studies in physics, chemical engineering and nuclear engineering, hosted by ANSTO under the MoU between ANSTO and the Korea Nuclear International Cooperation Foundation (KONICOF) for cooperation in nuclear human resource development.



ANSTO CEO Dr Adi Paterson FTSE signing the MOU with Korea.

\$18M from SIEF backs biomedical research

Australian biomedical research and businesses that utilise in-house research will receive a major boost thanks to \$17.9 million in funding from the Science and Industry Endowment Fund (SIEF) for two major collaborative efforts that will connect SMEs with researchers.

The first brings together CSIRO, Monash University and 20 industry players in a \$46 million program focusing on developing biomedical products from the bench to prototype and, via industry partners, to market. The Biomedical Materials Transformation Facility will be led by Monash University and CSIRO and based at their joint Clayton precinct in Melbourne, with partners MIMR-PHI (formerly Monash Institute of Medical Research and Prince Henry's Institute) and ANSTO.

The \$10 million SIEF investment, supported by CSIRO and Monash with the balance invested from emerging industry partners, has a particular focus on the three 'Ds' – materials and IP for delivery, diagnostics and devices – applied to the diagnosis and treatment of key chronic diseases, such as cardiovascular disease, cancer and ophthalmic diseases.

"This is a major collaborative effort between CSIRO, Monash and 20 emerging industry players and will build on Australia's global competitiveness," CSIRO Chief Executive and Science and Industry Endowment Fund Trustee Dr Megan Clark FTSE says.

A further \$7.9 million over five years will support a SIEF STEM+ Business Fellowship Program to place science, technology, engineering and mathematics (STEM) early-career researchers as researchers-in-residence in Australian business and industry.

The program aims to build deeper collaboration between researchers and SMEs, accelerating the adoption of new ideas and technology, and helping SMEs grow into larger, more profitable organisations. It will also create a cohort of researchers capable of addressing national challenges. With co-investment from participating organisations the program has the capacity to deliver \$17 million of research projects with Australian SMEs.

"Companies such as Anatomics, Textor and Universal Biosensors have seen the benefit of having researchers embedded in their business and we look forward to building on these successes and delivering similar benefits to other companies," Dr Clark says.

SIEF was founded in 1926 to fund innovation in Australian research and was reinvigorated with a \$150 million gift in 2009 from CSIRO from the proceeds of fast wireless LAN licensing.

SMARTPHONE APP HELPS HEART ATTACK PATIENTS

Patients recovering from heart attacks are far more likely to complete life-saving rehabilitation if they have access to a new smartphone app developed by CSIRO, research has shown.

A clinical trial found that cardiac patients who undertook rehab in their own homes via the smartphone app were almost 30 per cent more likely to take part in their program than those who had to travel to a clinic.

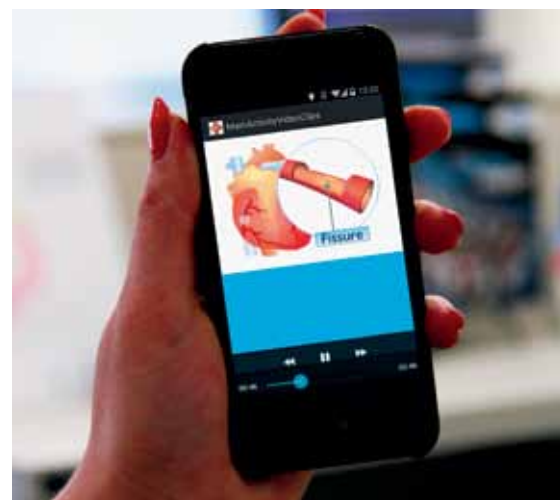
In addition, those who used CSIRO's smartphone home care delivery model – known as the Care Assessment Platform – were 40 per cent more likely to adhere to the program and almost 70 per cent more likely to see it through to completion.

The app features health and exercise monitoring tools, delivers motivational materials through text messages and contains multimedia that educates patients about disease symptoms and management.

The trial, which showed that the Care Assessment Platform model was just as clinically effective as traditional rehab, was so successful that the next version of the app will soon be offered in several Queensland hospitals.

According to Dr Mohan Karunanithi, from CSIRO's Digital Productivity Flagship, studies have shown that patients who complete cardiac rehabilitation following a heart attack have much better health outcomes. They are less likely to have another cardiac event, be readmitted to hospital or die from their condition.

The next step for the team is to adapt the platform for rehabilitation for other chronic conditions such as pulmonary disease and diabetes.



CSIRO's app is as effective as traditional rehab.

BACK ON HIS FEET WITH A PRINTED TITANIUM HEEL

CSIRO, St Vincent's Hospital, Melbourne, and biotech company Anatomics have linked to carry out world-first surgery to implant a titanium-printed heel bone into a Melbourne man.

Printed using CSIRO's state-of-the-art Arcam 3D printer, the heel bone was implanted into 71-year-old Len Chandler, a builder from Rutherglen, Victoria, who was facing amputation of the leg below the knee following a diagnosis of cancer of the calcaneus, or heel bone.

Working from Anatomics' schematics for the heel bone, teams at Anatomics and CSIRO developed the design requirements with Professor Peter Choong's surgical team from St Vincent's. Included in the design were smooth surfaces where the bone contacts other bone, holes for suture locations and rough surfaces to allow tissue adhesion.

Anatomics and CSIRO produced three implant prototypes in the days before the surgery. In the space of two weeks, from first inquiry to surgery, CSIRO and Anatomics were able to custom-design and present an implant part to the St Vincent's surgical team.



The printed titanium heel bone implant.

Scientists form ultra-thin 'diamond nanothreads'

American scientists say they have discovered how to produce ultra-thin 'diamond nanothreads' that promise extraordinary properties, including strength and stiffness greater than that of today's strongest nanotubes and polymers.

A paper describing this discovery by a research team led by Professor John Badding, at Penn State University, was published in the 21 September 2014 issue of the journal *Nature Materials*.

"From a fundamental-science point of view, our discovery is

intriguing because the threads we formed have a structure that has never been seen before," Professor Badding said.

The core of the nanothreads the team made is a long, thin strand of carbon atoms arranged just like the fundamental unit of a diamond's structure – zig-zag 'cyclohexane' rings of six carbon atoms

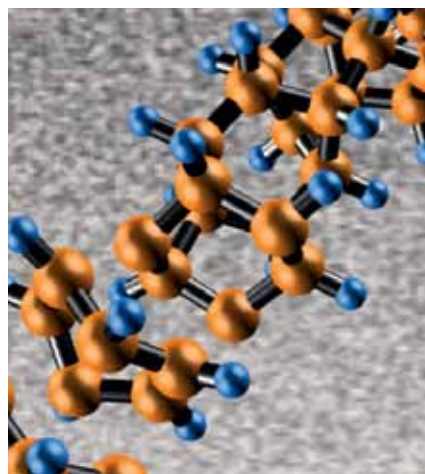


PHOTO: JOHN BADDING LABORATORY, PENN STATE UNI.

The diamond nanothreads.

bound together, in which each carbon is surrounded by others in the strong, triangular-pyramid shape of a tetrahedron.

"It is as if an incredible jeweller has strung together the smallest possible diamonds into a long, miniature necklace," Professor Badding said. "Because this thread is diamond at heart, we expect that it will prove to be extraordinarily stiff, extraordinarily strong and extraordinarily useful."

Professor Badding's team is the first to coax molecules containing carbon atoms to form the strong tetrahedron shape, then link each tetrahedron end to end to form a long, thin nanothread. The thread is only a few atoms across.

The compressed molecule is benzene, a flat ring containing six carbon and six hydrogen atoms. During the compression process, the benzene molecules stack together, bend and break apart. As researchers reduce the pressure, the atoms reconnect in an entirely different, but orderly, way: a nanothread.

RESEARCH UNLOCKS GRAPHENE POTENTIAL

Researchers at The University of Western Australia have discovered that nano-sized fragments of graphene – sheets of pure carbon – can speed up the rate of chemical reactions.

Graphene is remarkably strong for its low weight – about 100 times stronger than steel – and it conducts heat and electricity with great efficiency. The global market for graphene is reported to have reached US\$9 million this year, with most sales concentrated in the

semiconductor, electronics, battery energy and composites industries.

Assistant Professor Amir Karton, from UWA's School of Chemistry and Biochemistry, says the finding, published in *Chemical Physics Letters*, is significant because it suggested that graphene might have potential applications in catalysing chemical reactions of industrial importance.

Graphene is one of the most exciting materials to work with in nanotechnology because its two-dimensional structure and unique chemical properties make it a promising candidate for new applications such as energy storage and material composites, as well as computing and electronics, Assistant Professor Karton says.

"Ever since the discovery of graphene in 2004, scientists have been looking for potential applications in nanochemistry. Using powerful supercomputers, researchers at UWA discovered that graphene nanoflakes can significantly enhance the rates of a range of chemical reactions."

DSTO ON SHOW AT LAND FORCES 2014

A range of innovative technologies developed by the Defence Science and Technology Organisation were showcased in Brisbane at Land Forces 2014 – a conference and trade show, attended by more than 500 delegates and 450 exhibitors, focusing on how science and technology can transform the land force of the future.

Defence and topic experts from Australia, the US, the UK, Canada, Singapore and Norway spoke on future challenges including power and energy, next-generation land vehicles, autonomous systems and land force protection.

Some of the DSTO technologies included:

- A grenade launcher for non-lethal projectiles;
- A handheld device for detecting toxic chemical vapours;
- A digital video guard peripheral for secure internet transactions using any computer;
- A flexible, lightweight, outer-skeleton suit to reduce soldier fatigue;
- A ration pack chocolate bar with raw green banana starch to provide fibre plus energy for soldiers; and
- A device that harvests energy from vibrations to power sensors and electronics.

Land Forces 2014 was held at the Brisbane Convention and Exhibition Centre and organised by DSTO and the Australian Army.

'GREEN STEEL' TECHNOLOGY SAVES TWO MILLION TYRES

'Green steel' technology invented at the University of NSW has achieved a major milestone, with its use in Australia preventing more than two million waste rubber tyres from ending up in landfill.

The discarded tyres were used by OneSteel to manufacture steel in its Sydney and Melbourne facilities.

UNSW Scientia Professor Veena Sahajwalla FTSE collaborated closely with OneSteel as an industry partner to develop Polymer Injection Technology, in which old tyres and plastics provide a source of carbon to replace a significant proportion of the non-renewable coke used to make steel in electric arc furnaces.

"We are thrilled to have surpassed the two million tyre milestone," says Professor Sahajwalla, Director of the Centre for Sustainable Materials Research and Technology in the UNSW Faculty of Science.



The 3D titanium bike produced by Perth-based company Flying Machine in collaboration with CSIRO.

Australia's future in iManufacturing

Australia needs to play to its strengths and transition from traditional manufacturing into new areas of competitive advantage, according to a new CSIRO discussion paper, *Equipping Australian Manufacturing for the Information Age: iManufacturing – Is Australia Ready?*

The paper aims to generate discussion among Australian industry to prepare it for the move away from 20th century modes of production and allow it to compete on the world market.

The CSIRO paper says opportunities exist both domestically and internationally in the market for high-value, niche manufactured goods and associated services produced – if Australian industry were to adopt and utilise modern information technology and develop the associated skills to make best use of it.

Recognising the worldwide trend towards smaller batches of production, customised products, rapid prototyping, agile manufacturing processes and an emphasis on increased 'servitisation', the report's authors warn that Australian manufacturers must develop appropriate business models and prepare themselves for increasingly innovative and competitive offerings in terms of price and flexibility in their domestic and international market niches.

The discussion paper talks about businesses growing and evolving from the use of traditional IT-based technologies and into eManufacturing (dependent on cloud-based services) or progress further into iManufacturing (or informatics-linked manufacturing).

To compete globally, the report says, enterprises need to have the right skills and tools to do business and adapt to the future, including:

- Developing workers who combine not only eSkills (general computer/internet abilities) but also iSkills (understanding data, connectedness, the Internet of Things, servitisation) and manufacturing expertise;
- Encouraging and developing materialisation technologies that more rapidly turn digital, customised data into physical outputs;
- Developing collaborations and networks at local and global scales that are not only engaged at the human communications level but are sharers of data, resources, and processes;
- Improving supply chain interoperability and material flow efficiencies;
- Moving manufacturing industries increasingly into the service spaces – the servitisation of manufacturing; and

- Developing appropriate business models that maximise the potential that these new technologies provide.

Equipping Australian Manufacturing for the Information Age is available at www.csiro.au/Organisation-Structure/Flagships/Manufacturing/iManufacturingDiscussionPaper.aspx

OBJECTIVE 3D OPENS IN MELBOURNE

Australia's manufacturing took a step forward in October with the opening of Australia's largest additive manufacturing hub, Objective 3D, in Melbourne.

The new 3D printing additive manufacturing plant manufactures parts and devices for the mining, defence, biomedical, construction, aerospace and automotive industries more cost-effectively than traditional methods.

Michael De Souza, CEO of the Australian 3D Manufacturing Association, says 3D printing has the potential to revive manufacturing sectors such as tool making that are currently unable to compete globally from Australia.

"This centre provides Australian businesses with access to advanced manufacturing techniques and considerable savings of time and money in the stages of product development and production," Mr De Souza says.

Mr Matt Minio, Managing Director of Objective 3D, says the plant will initially employ 15 people and estimated the number would double over the next three years as the business grew. "Industry demand for this type of manufacturing process is growing at a rapid rate and we estimate, on average, we're reducing expenses to manufacturers by between 30 and 80 per cent, depending on application," he says.

Objective 3D is the largest distributor of Stratasys 3D printers in Australia and New Zealand.

BOOST FOR NULKA MISSILE DECOYS

Design of the next generation of anti-ship missile decoys is set to commence following the signing of two contracts between Defence and BAE Systems Australia Pty Ltd.

Defence Materiel Organisation Chief Executive Officer Mr Warren King says the contracts represent continued investment in the jointly developed Australian-US Nulka capability.

The Nulka decoy system is a ship-launched, rocket-propelled active decoy system designed to lure anti-ship missiles away from their intended target. It provides warships with a highly effective defence against anti-ship missiles, bringing together hovering rocket, autonomous system and electronic technologies. By 2019 the Nulka system will be fitted to 166 ships worldwide, including US, Canadian and Australian naval vessels.

"These contracts support both the acquisition of Nulka decoys and the engineering design of the next generation of shipboard Nulka launch systems for the Royal Australian Navy," Mr King says.

Valued at approximately \$80 million, the contracts will see Nulka decoys delivered to the RAN and the US Navy until early 2017, as part of the latest follow-on Nulka production order and the engineering design of the next generation of Nulka launch system.

"The Nulka decoy relies on a strong Australian supply chain and supports high-tech manufacturing in regional centres through the involvement of suppliers," Mr King says.



At the AMCU launch (from left) Private Stephanie Sims, Private Nicolette Lane, Corporal Dean George and Lance Corporal Keith Hall.

Diggers get new camouflage

After 13 years of continuous operations and observations of Army uniforms in harsh environments – and a continuous cycle of developing and testing equipment in the field – the Australian Army has developed the next generation of Army uniforms.

The Australian Multicam Camouflage Uniform (AMCU), launched in Brisbane and rolled out across the Army from October, is manufactured in Australia by the Australian companies Australian Defence Apparel and Pacific Brands Workwear Group.

Chief of Army, Lieutenant General David Morrison, says the AMCU represents the next generation of field and combat uniforms for soldiers. "Improvements to the design of the uniform will enhance a soldier's survivability and mobility and efficiently support a soldier's workload while still being functional in a variety of terrains and operating environments.

"For the first time, Army will introduce two separate uniforms. Both the AMCU field and combat variations use a tested Australian Multi-Camouflage Pattern that will take our soldiers from the bush to the desert and into the jungle."

INCAT FAST CREW BOAT HEADS TO THE CASPIAN

The 70-metre fast crew boat (FCB) headed for the Caspian Sea oil and gas industry was christened *Muslim Magomayev* in Hobart in September.

Built for Caspian Marine Services, based in Baku, Azerbaijan, the vessel honours Azerbaijan's famous opera and popular music singer Muslim Magomayev, who died in 2008.

It is the first vessel Australian shipbuilder Incat Tasmania has purpose-built for the oil and gas industry and will operate fast crew transfers for offshore workers to multiple installations in the Caspian Sea.

The high speed of the FCB will allow

operational efficiency over helicopter transfer for both passengers and cargo, while the semi-SWATH hull design, along with active ride control, are designed reduce stress on passengers.

The 200-tonne *Muslim Magomayev* is capable of carrying 150 passengers, 14 crew and 130 tonnes of deck cargo in up to 40-knot winds and three-metre seas at up to 35 knots. Passengers are accommodated on main and mid-decks, and the main deck also houses two VIP rooms, storage areas and a workshop.

The vessel's 16-metre beam is far narrower than is usual for an Incat catamaran but is determined by the width of the Volga-Don Canal that it must transit on its delivery from Hobart.

Muslim Magomayev will be the world's largest high-speed crew catamaran vessel operating in the global oil and gas industry, with power from four 2880kW MTU engines, each turning Hamilton HT 900 waterjets. The ship has been constructed from lightweight marine-grade aluminium over the past year at Incat Tasmania's Derwent Park Hobart shipyard.

NEW ELECTRICITY NETWORK MAPS

ARENA, the Australian Government's renewable energy agency, will fund the Institute for Sustainable Futures (ISF) at the University of Technology, Sydney (UTS), with \$425,000 to create online maps of electricity network constraints to help better inform network investments and increase the use of renewable energy.

"Currently there is a lack of clear, accessible and timely network information across the National Electricity Market," says ARENA CEO Mr Ivor Frischknecht. "A consistent, standardised approach will be developed with Australia's poles and wires businesses to make data more accessible and easier to understand and use.

"The maps will help renewable energy and demand management project developers to anticipate network constraints, reduce the need for new grid infrastructure and lower electricity bills. The new maps may also enable faster development of renewable energy by showing where renewables and demand management can be more cost effective than network upgrades."

ISF Research Director Mr Chris Dunstan says the energy sector is changing quickly and new tools are needed to manage this transition.

"The rapid rise of rooftop solar, local generation, energy-efficient equipment and battery storage means managing networks is becoming both more challenging and more collaborative," Mr Dunstan says.

"The three-year project will provide a key resource for developing this collaboration between networks, customers and renewable energy providers. It has the potential to lower electricity costs, improve energy

services and develop new markets for networks and renewable energy."

The project has support from the network industry through partnerships with Ergon Energy, ElectraNet and TransGrid. Other project partners include ARENA, ISF and the NSW Department of Trade and Investment.

The *Muslim Magomayev*.



Solar to power remote Northern Territory

Remote communities in the Northern Territory (NT) will benefit from solar power under a \$55 million project funded by the Australian Renewable Energy Agency (ARENA) and the NT Government, to be managed by the NT Power and Water Corporation (PWC).

The majority of installations will achieve 15 per cent diesel fuel displacement from an aggregate 9 MW solar PV system. One high-penetration system at Nauiyu (Daly River) will achieve approximately 50 per cent diesel fuel displacement through a 1 MW solar PV facility using advanced technologies such as cloud forecasting and energy storage.

The program will see solar panels integrated via a control system into existing diesel power stations to create solar/diesel hybrid power stations in remote indigenous NT communities.

ARENA CEO Ivor Frischknecht joined the Minister for Industry, Ian Macfarlane, and the NT Chief Minister, Adam Giles, to announce the project in Darwin. Community consultations, design and site work will begin shortly, with construction due to commence in 2016.

Mr Frischknecht said ARENA and the NT Government would each provide \$27.5 million to roll out cost-cutting solar photovoltaic (PV) systems to off-grid communities, where energy demand and costs were increasing.

"ARENA is very pleased to be partnering with Indigenous Essential Services – a subsidiary of PWC – to deliver this exciting project, which will see a total of 10 MW of solar PV constructed at more than 30 remote communities in the NT," Mr Frischknecht said.

He said remote communities had, for too long, had no option but to rely on diesel generators that were expensive to run and subject to volatile fuel prices. "By integrating solar PV into existing diesel power stations, this project will reduce each community's reliance on costly diesel for electricity generation.

"Importantly, the project will demonstrate the enormous advantages of solar/diesel hybrid systems in delivering cost-effective, reliable and safe power to remote locations."

UNSW SUNSWIFT BREAKS ELECTRIC CAR RECORD

A team of UNSW engineering students has been officially recognised as the new world-record holders for the fastest electric vehicle over a distance of 500 kilometres.

The Fédération Internationale de l'Automobile (FIA), world motorsport's governing body, has updated its official record with the 106.966 kilometres/hour set by team Sunswift in July; the previous record (73 kmh) stood for 26 years.

Sunswift is Australia's top solar car racing team. Its current vehicle eVe is the fifth to be built and raced since the team was founded in 1996. More than 100 undergraduate students contributed to Sunswift's successful world record attempt over the past two years.

UNSW Engineering Dean Professor Graham Davies FTSE congratulated the students for what he called "another exceptional feat".

Earlier versions of the Sunswift car have been used to set a world record for the fastest solar-powered road trip from Perth to Sydney, and a Guinness World Record for the fastest solar car.

NTU DEVELOPS FAST-CHARGING, 20-YEAR BATTERIES

Scientists at Singapore's Nanyang Technology University (NTU) have developed ultra-fast-charging batteries they claim can be recharged to 70 per cent in only two minutes and which have a lifespan of more than 20 years, more than 10 times that of existing lithium-ion batteries.

With this technology, drivers of electric vehicles could save on battery-replacement costs and recharge their cars in minutes.

Commonly used in mobile phones, tablets and electric vehicles, rechargeable lithium-ion batteries usually last about 500 recharge cycles. This is equivalent to two to three years' typical use, with each cycle taking about two hours for the battery to be fully charged.

In the new NTU-developed battery, the traditional graphite used for the anode (negative pole) in lithium-ion batteries is replaced with a new gel material made from titanium dioxide – an abundant, cheap and safe material found in soil and commonly used as a food additive or in sunscreen lotions to absorb harmful ultraviolet rays.

Naturally found in spherical form, the NTU team says it has found a way to transform the titanium dioxide into nanotubes, a thousand times thinner than the diameter of a human hair, which speeds up the chemical reactions taking place in the new battery, allowing for superfast charging.

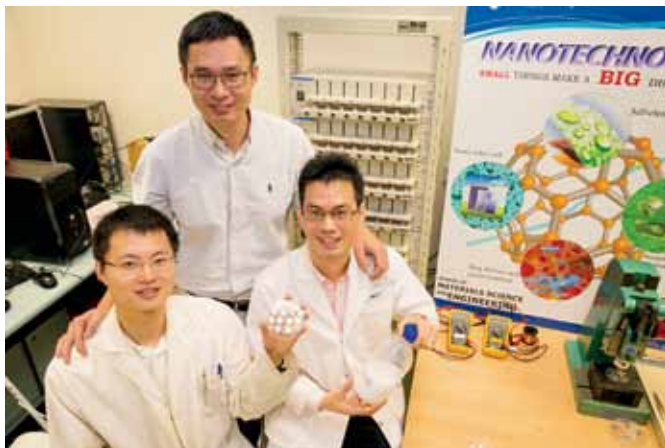
Invented by Associate Professor Chen Xiaodong from NTU's School of Materials Science and Engineering, the science behind the formation of the new titanium dioxide gel was published in the latest issue of *Advanced Materials*, a leading international scientific journal in materials science.

"Electric cars will be able to increase their range dramatically, with just five minutes of charging, which is on par with the time needed to pump petrol for current cars," Professor Chen says.

"Equally important, we can now drastically cut down the toxic waste generated by disposed batteries, since our batteries last 10 times longer than the current generation of lithium-ion batteries."

The global market for rechargeable lithium-ion batteries is projected to be worth US\$23 billion in 2016.

NTU Professor Rachid Yazami, the co-inventor 30 years ago of the lithium-graphite anode that is used in today's lithium-ion batteries, says Professor Chen's invention is the next big leap in battery technology.



(Clockwise from top) Professor Chen with research fellow Tang Yuxin and PhD student Deng Jiyang.

Gladesville Bridge: world's longest concrete arch-span bridge until 1980.



Gladesville Bridge honoured by EA

Sydney's Gladesville Bridge, once the world's longest concrete arch-span bridge – and one of the first large bridge designed with the aid of computers – has been awarded an Engineering Heritage International Marker to mark the 50th anniversary of its opening.

"This global engineering icon represents a significant advancement in bridge design and construction," said Alexandra Meldrum, President of Engineers Australia's Sydney Division.

"It was a bold and ambitious project conceived and constructed during the Australian post war-expansion of the 1950s and 1960s.

"Stretching 305 metres across the Parramatta River, it held the title of world's longest concrete arch-span bridge from its completion in 1964 through to 1980. To achieve this length, the engineers implemented several innovative methods, which have since become widely adopted.

"Anthony Gee of G. Maunsell & Partners designed the bridge in the 1960s, writing a suite of computer programs to capitalise on the newly discovered power of computers. This makes the Gladesville Bridge one of the first computer-designed bridges.

"The engineers also used pre-cast concrete segments, which was a first for a major concrete arch bridge, marking the shift away from steel which had dominated bridge construction at the time."

WOODSIDE INVESTS \$10M IN EZONE AT UWA

Oil and gas producer Woodside has made a \$10 million investment in The University of Western Australia's revolutionary engineering research, teaching and learning facility project, known as EZONE UWA.

EZONE UWA, headed by Dr Peter Lilly FTSE, former WA Division Chair, will deliver new and improved teaching and research infrastructure and enable UWA's Faculty of Engineering, Computing and Mathematics to equip current and future students with the best skills and knowledge through state-of-the-art facilities.

These facilities will provide a network of flexible teaching and research spaces to promote collaboration, innovation and new thinking at a time when graduates and researchers must adapt to frequently changing industry practices and requirements.

UWA Vice-Chancellor Professor Paul Johnson said UWA welcomed Woodside's generous investment, which would help the university's bold vision to equip WA and the world with engineers, computer scientists and mathematicians who can solve far-ranging problems that arise in multiple disciplines.

Woodside CEO and UWA Adjunct Professor Peter Coleman FTSE said the company was proud to invest \$10 million in the EZONE, which had the potential to revolutionise engineering education in WA.

BUILDING TRUST IS KEY TO MINING'S 'SOCIAL LICENCE'

Australians endorsed the important role mining plays in the nation's prosperity but there is still much to be done to bolster public acceptance, trust and support of the industry, according to a new CSIRO report.

Australian attitudes toward mining is based on a survey of more than 5000 people Australia-wide. According to lead researcher, Dr Kieren Moffat, it provides insight and data on community attitudes and possible ways for the sector to build its future opportunities and 'social licence to operate'.

"A key finding is that Australians consider that mining is a worthwhile pursuit when you weigh up all the associated benefits and costs," Dr Moffat says. "The survey shows Australians broadly accept mining and that acceptance underpins the social licence to operate, but it shows that support is fragile and subject to things like perceptions of mining impacts, governance and the sharing of benefits."

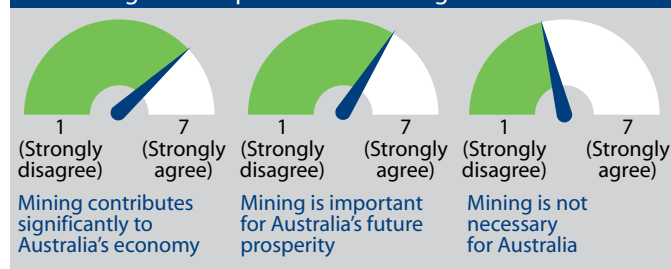
The survey, in 2013-14, covered 1283 people living in or near mining operations in 11 identified regions, as well as 1562 people living in non-mining regions and 2276 people in metropolitan areas across the country. It forms part of a larger CSIRO program of work examining the relationship between mining and society at different scales in Australia and internationally – with a similar report just released for Chile.

"Australians across mining, non-mining and metropolitan regions strongly agreed that mining contributes significantly to the economy, to the standard of living, to our way of life and our future prosperity. Those surveyed in each group also generally agreed that mining creates jobs, opportunities and infrastructure in regions," Dr Moffat says.

"There are however relatively strong community perceptions that mining impacts negatively on the environment, water quality, agriculture, climate change and the health of local communities."

Those surveyed expressed mid-range levels of trust in state and federal governments, the industry and non-government organisations and a below mid-range rating of the capacity of governments or legislation to keep the industry accountable.

Figure 1 Importance of mining in Australia



Mining was viewed as a central and significant contributor to Australia's economy and standard of living, as a 'necessary' industry for Australia, and as important to Australia's future prosperity.

Minerals roadmap to drive deeper exploration

AMIRA International is behind a minerals industry initiative to deliver a roadmap that will help unlock Australia's hidden mineral wealth by greatly improving the ability to find new mineral resources buried under widespread cover sediments.

More than 70 per cent of the country is covered by deep, post-mineralisation regolith and sedimentary cover. Current known mineral endowment is mostly confined to the outcropping and shallow covered areas of the country.

AMIRA is working with the Centre of Exploration Targeting (UWA), CSIRO, Curtin University and the UNCOVER Group.

Joe Cucuzza, Managing Director of AMIRA International, says the *Unlocking Australia's hidden potential Roadmap* resulted from a number of discussions with stakeholders including deliberations at the inaugural UNCOVER summit convened in April 2014 in Adelaide.

"The initiative is currently supported by 32 Australian and international mineral exploration and mining companies, large and small, minerals equipment, technology and service (METS) suppliers, government geological agencies and industry bodies. We continue to receive enquires and are expecting more companies and organisations to join this important initiative," Mr Cucuzza says.

Output from the roadmap is anticipated to be industry-wide consensus on:

- A vision of the future state of the exploration industry;
- Key technical and scientific gaps/barriers/impediments that need to be addressed to improve exploration success in areas of cover;
- New data, knowledge and concepts required to develop a rigorous mineral systems approach across all scales, and apply this approach to exploration under cover;
- A plan for tackling these steps and a timeframe for doing so; and
- Identification of the research capability and resources necessary to deliver over the agreed time period, including identification of possible research vehicles that could be utilised to deliver on the vision.

Ultimately the purpose of the roadmap is to deliver a plan to stimulate innovation and strategic investment by companies, research providers and governments that will grow Australia's mineral wealth and sustain a revenue stream for the country's future.

AMIRA International is a global, not-for-profit, member-based organisation with offices on four continents and current research projects with researchers in eight countries. Members include most of the world's largest mining companies, and many junior explorers and METS suppliers.

UNCOVER is a national strategy to integrate scientific research into current technology research and pre-competitive data acquisition. It was established to provide an effective forum to further stimulate a collaborative partnership between all minerals exploration stakeholders to benefit all stakeholders and in the Australian national interest.

FUGRO TO FUND UWA GEOTECHNICS CHAIR

Fugro, an international company that specialises in the design of offshore foundations, will fund the creation of a new chair at UWA's Centre for Offshore Foundation Systems (COFS).

The Fugro Chair in Geotechnics aims to develop a sustainable research group, to address key questions related to design and performance within the field of offshore geotechnics, reducing risk and enhancing engineering design within the offshore sector.

The agreement, which also provides funding for three PhD scholarships, was signed by UWA Deputy Vice-Chancellor (Research) Professor Robyn Owens FTSE and Dr Phil Watson, Director of Fugro Advanced Geomechanics in Perth and Fugro's Global Service Line Manager GeoConsulting.

COFS Director, Winthrop Professor Mark Cassidy FTSE, says the partnership between Fugro and COFS will help ensure research was targeted to solving real-world problems.

The investment is part of UWA's New Century Campaign, which aims to raise \$400 million to support its investment in research and education.



Robyn Owens

RIO TINTO LAUNCHES 3D MAPPING TECHNOLOGY

Rio Tinto aims to capture a crucial advantage in the recovery of mineral deposits, with the launch of its revolutionary three-dimensional mapping technology to reduce costs and improve the efficiency of mining operations.

The new technology will enable Rio Tinto to precisely identify the size, location and quality of ore in real time by retrieving data from automated trucks and drills operating in its mines.

The RTVis™ 3D software creates images of mine pit activities that previously could not be measured and can provide accurate mapping which improves mining efficiency by focusing on removing high-value ore.

RTVis™ has led to greater ore recovery through sharper boundary identification, more accurate drill blasting, reduced explosives, improved waste classification and enhanced dig rates.

Rio Tinto Global Head of Innovation, Mr John McGagh FTSE says: "This technology allows us to quickly and easily view, compare and evaluate data to paint a picture of what's under the ground – it's like an ultrasound image of the deposit delivered in real time, something that we could never do before.

"RTVis™ is a low-cost application that complements existing group-wide data technology in a way previously never available to enhance our mining operations. It quickly brings information to a much broader audience – from a single operator in the field to an expert team in the Rio Tinto Operations Centre in Perth.

"Armed with this detailed information, our operations to recover the ore bodies will be significantly more efficient and effective."

The new 3D technology is deployed at Rio Tinto's West Angelas iron ore mine in WA and trials are also underway in other Rio Tinto product groups including copper, energy and diamonds and minerals.

RTVis™ also provides rapid feedback on the impact to equipment while another important benefit is in the area of mine planning, providing much more certainty about the nature of the ore deposit at an earlier stage of the process.

John McGagh



Cisco and Swinburne to partner on research

Swinburne University of Technology and Cisco have signed an agreement to collaborate on new research initiatives on the 'Internet of Everything'.

Under the agreement, Cisco and Swinburne will pursue new innovative approaches in learning environments that integrate pedagogy, facilities and technology to support increased student participation rates and broader educational objectives.

This agreement follows a recent arrangement between Swinburne, Cisco and Logicalis Australia to provide intelligent networking, software and services for the university's project to upgrade its existing campus ICT infrastructure to deliver a next generation platform for simple and effective communication and collaboration across physical and virtual campus and distance-learning environments.

"Cisco and Swinburne share the common vision of enhancing educational outcomes through the effective use of technology to improve lecture practice, underpin modern facilities development, promote more effective university and system management, and improve student and community engagement in learning," Swinburne Acting Vice-Chancellor Professor Jennelle Kyd says.

Tim Fawcett, general manager of Government Affairs and Policy for Cisco Australia and New Zealand says if universities are to thrive and prosper in the Digital Economy, the right enablers must be in place.

"Embracing the power of technology in all aspects of its operations as Swinburne has in its administration, teaching and learning and research is one of the most critical enablers as it provides the platform for innovation.

"With our commitment to engage in research on the Internet of Everything, Cisco and Swinburne are preparing students to imagine and invent solutions that take advantage of a world where everything is connected," Mr Fawcett says.

Cisco Systems, Inc. is an American multinational corporation that designs, manufactures and sells networking equipment. Cisco describes itself as the worldwide leader in networking that transforms how people connect, communicate and collaborate.



This video wall illustrates the possibilities of the Internet of Things.

IoE OR IoT?

Cisco defines the 'Internet of Everything' (IoE) as bringing together people, process, data and things to make networked connections more relevant and valuable than ever before, turning information into actions that create new capabilities, richer experiences and unprecedented economic opportunity for businesses, individuals and countries.

Wikipedia describes the 'Internet of Things' (IoT) as the interconnection of uniquely identifiable embedded computing devices within the existing Internet infrastructure. Typically, IoT is expected to offer advanced connectivity of devices, systems and services that goes beyond machine-to-machine communications (M2M) and covers a variety of protocols, domains and applications. The interconnection of these embedded devices, is expected to usher in automation in nearly all fields, while also enabling advanced applications like smart grids.

Things, in the IoT, can refer to a wide variety of devices such as heart monitoring implants, biochip transponders on farm animals, vehicles with built-in sensors, or field operation devices that assist fire-fighters in search and rescue. Current market examples include smart thermostat systems and washer/dryers that utilise wifi for remote monitoring.

Research anticipates that more than 30 billion devices will be wirelessly connected to the IoE/IoT by 2020.

FIVE AUSTRALIANS MAKE THE TOP 100 LIST

Five Australian universities were ranked in top 100 in the latest Times Higher Education world university rankings – Melbourne (33), ANU (45), Sydney (60), UQ (65) and Monash (83).

Another three were ranked in the top 150 – UNSW (109), UWA (157) and Adelaide (164). UTS was ranked 226–250, Newcastle 251–275 and three in the 276–300 bracket – QUT, UniSA and Wollongong.

SOFTWARE OPENS WINDOWS TO SCIENCE

New software that offers scientists and researchers an easy way to analyse, model and visualise scientific datasets has been released by CSIRO.

The free software, known as Workspace, is purpose-built for scientific applications and allows researchers to present their findings through stunning visualisations. Developed over the past eight years at CSIRO, Workspace has already been used for a wide range of projects, including natural disaster modelling, human movement, and industrial and agricultural research.

One CSIRO team has already used the software to model and visualise simulations for storm surges and flash flooding, assisting disaster management planning.

Working with the Australian Institute of Sport, another team produced a 3D biomechanical model of different swimming strokes, enabling athletes to adjust their technique for maximum performance.



Chem World was conceived and championed by Sean Druiitt and Anne Brant.

Chem World: a two-storey chemistry textbook

Queensland University of Technology claims its new Chem World – a two-storey interactive display at The Cube at QUT – is the world's largest interactive chemistry textbook.

Developed in partnership with hundreds of students, teachers, academics and scientists, Chem World links directly to the new Australian curriculum for chemistry and allows students to conduct virtual chemistry experiments too dangerous or difficult to run in a classroom – including launching rockets into orbit and creating colourful fireworks.

"Chemistry is fascinating but it involves concepts that are quite difficult to comprehend," says QUT's STEM-teacher-in-residence Anne Brant, who co-conceived and championed the project.

"Students often have trouble moving from the physical side of chemistry into the abstract concepts that underpin the things they can see and touch. Because Chem World is highly visual, it can explain the abstract more easily than your traditional textbook – it's an intuitive, informative experience with a library of knowledge accessible at a finger's touch."

Chem World contains three interactive experiments where users can:

- Produce spectacular virtual firework displays to learn why some chemical elements produce colour and discover the 'fingerprints' of elements;
- Compete with others to launch rockets into space in order to explore how fuels produce energy and compare different fuel types; and
- See how water behaves at a molecular level and what happens when substances are added, in order to learn about solubility and what makes some things dissolve in water when others do not.

The interactive display was built by game developers in The Cube's studio team. Co-creator and studio manager Sean Druiitt says his team spent 18 months engaging with the community and six months coding the software to bring it to life.

"We have a modest team of eight staff and what we've produced is quite spectacular. And we'll be adding more chemistry experiments and modules in the future. We've enjoyed working collaboratively with the community to build Chem World and the project has opened the door

for us to engage with the community on future projects tackling other traditionally dry subjects, like mathematics."

Brisbane schools are already planning to incorporate Chem World into their lesson plans.

"Students today have grown up in a digital world and they relate far more to technologies like this than the hard-copy textbooks older generations are used to," Kelvin Grove State College Head of Science Karen Gosney says. "As educators, we will rely more and more on digital tools like this to enhance the learning experience for students."

CO₂ EMISSIONS REACHED 36 BILLION TONNES IN 2013

Global emissions of carbon dioxide from the combustion of fossil fuels reached a new record of 36 billion tonnes last year and the pace of emissions from burning fossil fuels continues to grow at a high rate, according to new research.

Executive Director of the Global Carbon Project (GCP), CSIRO's Dr Pep Canadell, says the CO₂ level is "unprecedented in human history".

Dr Canadell says fossil fuel CO₂ emissions are projected to increase 2.5 per cent this year, bringing the total CO₂ emissions from all sources to more than 40 billion tonnes.

"Fossil fuel emissions in the past 10 years on average grew at 2.5 per cent per year, lower than the growth rate in the 2000s (which was 3.3 per cent per year) but higher than the growth rate in the 1990s (one per cent)," Dr Canadell says.

"The declining growth rate in recent years is associated with lower GDP growth compared to the 2000s, particularly in China."

Australian emissions continued to decline in 2013, adding to a downward trend that began in 2009, largely due to the decline in electricity generation from coal power plants. The largest emitters in 2013 were China, the US, the European Union and India, together accounting for 58 per cent of global emissions.

The GCP provides an annual report of CO₂ emissions, land and ocean sinks and accumulation in the atmosphere, incorporating data from multiple research institutes from around the world.

BOM UPGRADES CLIMATE OUTLOOKS SERVICE

The Bureau of Meteorology's revamped Climate Outlooks now offers more detail, with monthly outlooks and the ability to zoom in on any geographic location in Australia, reflecting the needs of users.

The BoM has issued seasonal climate outlooks since 1989, featuring three-month outlook maps and analysis of what to expect on the climate front, compared to the average. The new Climate Outlooks service provides monthly rainfall and temperature information and guidance on the likely climate conditions for separate months, as well as for the three-month season.

"We heard from more than 900 users, many from the agricultural sector, and we learnt that while most users understood the outlook maps, others needed assistance to interpret the information," said Dr Andrew Watkins, Manager of Climate Prediction Services at the Bureau.

"In response, we produced short videos explaining the outlook probabilities for wetter or drier and cooler or warmer seasons, and the climate influences driving them."

By Ian Rae
iandrae@bigpond.com



Taking a traditional craft into a new age

Although you won't read it in this book, 3D printing is descended from a traditional craft, that of pattern-making, in which solid objects are built up with successive layers of material.

There are examples in the pattern shop of my local maritime museum but other industries had them, too. Wood slices from 10 to 15 millimetres thick were cut to shape and glued together before final hand work to produce a smoothly contoured surface. The pattern was then used (and re-used) to create a mould in a sandbox from which metal castings could be produced.

In the modern world of additive fabrication, a digital image created from an object, or simply by an artist, is transferred to a machine that consists, in its most basic form, of a nozzle for exuding material and a platform on which layers of material can be deposited.

The 'how to' part of this book, Chapter 2, describes how a thermoplastic material can be melted, mechanically extruded and deposited on the platform – a 'build tray' – by moving the extrusion nozzle on a computer-driven pathway. Each ultra-thin layer cools and hardens before the next is applied.

In this way a 3D object can be constructed, together with any supports required to ensure that it stands up. Such extraneous material, just like the runners and risers on a metal casting, is removed before the object is put to use, and in both crafts some surface finishing is usually required.

Softer materials and solutions can be extruded pneumatically with solvent evaporation after deposition. Another technique uses something like an ink-jet printer to eject a fine stream of droplets, and this technique is especially suitable for photo-curable materials when a UV source is used to harden the growing layers.

To work without the extruder and without liquids, powdered material can be spread on the build tray and selected regions fused by a wandering laser or electron beam. Low energy is enough to fuse polymers, but higher energies are

needed to fuse or sinter metal particles.

Cobalt chromium dental crowns are the archetypal products of such a process but they are expensive: I recently missed out on a close encounter with 3D by choosing a ceramic crown instead. Constructing ceramic objects is a two-stage process, the first involving printing with a mixture of organic and inorganic material, after which the object is fired in a conventional kiln to burn off the organic matrix and harden the final ceramic structure.

While hard prostheses have been produced, and some frameworks into which tissue of various kinds can be induced to grow, the researchers' aim is 'printing bits for

and high-altitude marathon runners.

I was puzzled why so many authors – including Professor Gordon Wallace FTSE – were needed for such a small book, but each brought a specialty to the task, from polymer science to graphic communication to biomedical ethics.

I had a personal reaction to whoever wrote: "In our youth we think of our skeleton as our strength and our core. The truth is that every step we take may be wearing down that strength, eroding our scaffold from within." I had been wondering how my laser printer with its narrow exit could give birth to the prosthesis I need for my

knee. This book helped me to understand that a CAD-CAM machine, big brother to my laser, will be needed for the job.

The book is an excellent introduction to this multidisciplinary field, with excellent cartoons and case studies, and lists of selected readings for those who wish to know more.

There's no index but if you get the ebook it's word-searchable and the videos are a bonus.

A printed jaw for the future.



bodies' – the construction of biomaterials that can be used to repair tissue damaged by illness or trauma. Even replacement organs such as livers and kidneys are in their sights.

The technical issues are formidable, not the least being microorganism contamination and infection control.

Ethical issues are raised by necessary trials of new materials and by questions of who should benefit from new technologies that might become available to repair or to enhance bodies.

Super-humans enhanced in age, strength, endurance or memory sound a bit like 'Frankenfoods', but they could be already among us. Think athletes on steroids

Professor Gordon Wallace FTSE is an ARC Laureate Fellow, Executive Research Director of the ARC Centre of Excellence for Electromaterials Science, Director of the Intelligent Polymer Research Institute, University of Wollongong, and Director of the Australian National Fabrication Facility, Materials Node.

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.

3D Bioprinting: Printing Parts for Bodies by GG Wallace, RC Cornock, CD O'Connell, S Beirne, S Dodds & F Gilbert (ARC Centre of Excellence for Electromaterials Science, 2014, 60 pp, \$4.99). The ebook version including animations and additional content is available at 3dbioprint.creatavist.com/3dbioprinting and also from Amazon.

ATSE IN FOCUS

Five Fellows named to new Science Council



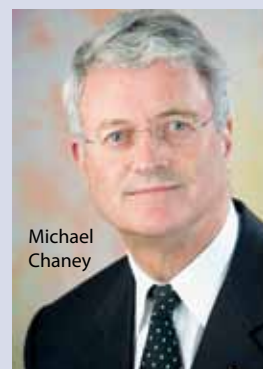
David Knox



Catherine Livingstone



Tanya Monro



Michael Chaney

Half the members of the Government's new Commonwealth Science Council, which will replace the previous Prime Minister's Science, Engineering and Innovation Council (PMSEIC), are Fellows of the Academy.

The Academy Fellows appointed by the Government are:

- Mr Michael Chaney AO FTSE
- Professor Ian Frazer AC FAA FTSE
- Mr David Knox FTSE
- Ms Catherine Livingstone AO FAA FTSE
- Professor Tanya Monro FAA FTSE

Mr Chaney is Chairman of National Australia Bank, Woodside Petroleum and Gresham Partners. He is Chancellor of The University of Western Australia, a member of the JPMorgan International Council and a Director of the Centre for Independent Studies. He is a former Director of BHP Billiton and was CEO of Wesfarmers (1992 to 2005).

Professor Frazer, Chief Executive of the Translational Research Institute in Brisbane, is acknowledged worldwide for his work in developing successful human papilloma virus vaccines against cervical cancer. He is a former winner of the Eureka Prize (2005), Australian of the Year (2006), the Clunies Ross Award (2007) and the Prime Minister's Prize for Science (2008).

Mr Knox is Managing Director and Chief Executive Officer of Santos and has more than 30 years' experience in the global oil and gas industry, including as Managing Director for BP Developments in Australasia (2003–07). He previously held senior positions with BP in Australia, the UK and Pakistan, and management and engineering roles at ARCO and Shell in the US, Netherlands, the UK



Ian Frazer

and Norway. He is a Director of the Migration Council Australia, Council Member of the Business Council of Australia and Chair of the CSIRO Energy Strategic Advisory Committee.

Ms Livingstone is Chairman of Telstra and President of the Business Council of Australia. She is a Director of WorleyParsons (since 2007) and was on the boards of Macquarie Bank Ltd (2003–13) and Macquarie Group Ltd (2007–13). She was Chairman of CSIRO from 2001–06 and has also served on the boards of Goodman Fielder and Rural Press. Ms Livingstone was the Chief Executive of Cochlear Ltd (1994 to 2000).

Professor Monro is an ARC Georgina Sweet Laureate Fellow and is Director of the ARC Centre of Excellence in Nanoscale BioPhotonics and of the Institute for Photonics and Advanced Sensing (IPAS) at The University of Adelaide. She became Deputy Vice-Chancellor Research and Innovation at the University of South Australia in November. She is a member of the SA Premier's Science and Industry Council, a former SA Scientist of the Year and a winner of the Pawsey Medal and Telstra Businesswomen of the Year.

ELIZABETH DENNIS WINS FARRER MEDAL

Dr Elizabeth Dennis FTSE, from the CSIRO Agriculture Flagship, has won the 2014 Farrer Medal. The award recognises Dr Dennis' contribution as a leading researcher in gene expression, the molecular bases of plant development, plant gene regulation, mapping plant genomes and the fundamentals of flower initiation. This research encompasses the basic functions upon which all successful grain production depends.

It was presented to her by the Chairman of the Farrer Memorial Trust, Mr Scott Hansen, at the COMBIO Conference in Canberra on 30 September 2014. Mr Hansen is Director-General of the NSW Department of Primary Industries.

Following the presentation, Dr Dennis gave the 2014 Farrer Oration, 'Arabidopsis and agriculture: what can we learn from a weed?'

Her oration discussed recent science underpinning the potential to make beneficial selections from the results of hybridisation and to maintain the gains obtained.



Elizabeth Dennis receives the 2014 Farrer Medal from Scott Hansen.

ATSE IN FOCUS

Chief Scientist elected an ATSE Fellow

Australia's Chief Scientist, Professor Ian Chubb AC FTSE heads an impressive list of science and technology leaders elected as Fellows of the Academy of Technological Sciences and Engineering.

The 2014 new Fellows include 25 key business names, leading academics, prominent commercial innovators, professional and business leaders, and high-ranking public sector figures.

The new Fellows include eight prominent women – sustaining again the Academy's policy of electing one-third of its new Fellows from female candidates.

They come from a wide array of sectors and specialisations including agriculture, engineering, aviation, astronomy, marine science, government, vulcanology, sustainable systems, innovation management, water management, biotechnology and medical research.

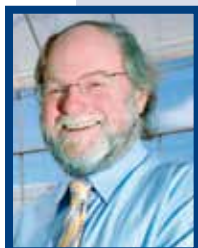
2014 FELLOWS



PROFESSOR IAN CHUBB AC FTSE
Chief Scientist of Australia (ACT)

Professor Chubb is recognised internationally for outstanding leadership in higher education. His contributions over 30 years cover

university governance, administration, education, research and science policy. He championed the strategic role of STEM in meeting social and economic challenges and created structures linking science to national policies, to education and to social awareness of science.



PROFESSOR JAMES DALE AO FTSE
Queensland University of Technology (Queensland)

Professor Dale is Director of QUT's Centre for Tropical Crops and Biocommodities

and is internationally recognised as an agricultural biotechnologist who has applied and commercialised his research, nationally and internationally. His work on bananas over the past 30 years has resulted in eliminating diseases and boosting nutrients.



DR ROSALIND DUBS FTSE
Director, Aristocrat Leisure Ltd, ANU Enterprise Ltd, ASC Pty. Ltd (NSW)

Dr Dubs has led international

engineering businesses in Europe and Australia and served at senior executive levels of two universities as well as Airservices Australia. She has driven the inclusion of Australian products in global supply chains and has contributed significantly to strengthening university/industry engagement. She chaired the Space Industry Innovation Council 2010–12.



MR MICHAEL EDWARDS FTSE
General Manager, Boeing Research and Technology Australia (Victoria)

Mr Edwards has a broad industry experience and knowledge and

knows how technology and innovation add value to business. He spent 11 years in senior roles with CSIRO and, as General Manager of Boeing Research and Technology, has focused on maximising impact for industry from R&D investments. Boeing Research and Technology Australia has grown to be Boeing's largest international research centre outside the US.



PROFESSOR GEOFFREY FINCHER FTSE
University of Adelaide (SA)

Professor Fincher, as Director of the

ARC Centre of Excellence in Plant Cell Walls, leads major national research programs giving critical insights into the structure and biological significance of carbohydrates and enzymes in cereal crops, notably wheat and barley, with commercial applications in plant breeding, food processing, human health and renewable fuel production.

PROFESSOR ANNE GREEN FTSE
University of Sydney (NSW)

Professor Green is Professor of Astrophysics at the University of Sydney and has been a trailblazer for women in physics and, as the first female Head of the School of Physics, was a strong influence on research excellence. She has outstanding achievements in astronomy and telescope technology and made a significant impact on planning for the Square Kilometre Array.



MR JOHN GUNN FTSE
Australian Institute of Marine Science (Queensland)

Mr Gunn is CEO of AIMS, with 34 years of

achievement in marine science supporting policy development, R&D, management and the sustainable development of marine industries, especially fisheries. His expertise has been recognised in his appointment to many national and international science committees, review panels and boards.



PROFESSOR MARK HOFFMAN FTSE
University of New South Wales (NSW)

Professor Hoffman, Pro Vice-Chancellor (Research) at

UNSW, has made significant contributions to industry in the field of materials design and technologies for structural integrity and reliability, covering a range of disciplines in light metals, thin films, nanomechanics

ATSE IN FOCUS

and polymers. He contributes strongly to engineering education and bridging the fields of science and engineering.



**MR COLIN
JENSEN FTSE**
**Brisbane
City Council
(Queensland)**

Mr Jensen is CEO of Brisbane City Council, the largest council in Australia,

serving a population of 1.1 million. He is a civil engineer with responsibility for major local and state infrastructure projects – significantly influencing and improving city and state infrastructure and driving organisational change and improvement.



**DR ANDREW
JOHNSON FTSE**
**CSIRO
(Queensland)**

Dr Johnson, a CSIRO Group Executive, is a globally recognised researcher and research leader

who has made significant contributions to the sustainable development of rural and regional Australia. Dr Johnson has excelled in the field of natural resource management and has delivered substantive outcomes to industry, government and the wider community.



**DR MARLENE
KANGA AM FTSE**
**Director,
iOmniscient Pty Ltd
(NSW)**

Dr Marlene Kanga is a significant engineering leader and a former

National President, Engineers Australia. As Director of iOmniscient she led the development of world-class Australian video analytics technology, which is being implemented globally. She is a passionate advocate for engineering and has implemented frameworks to make the engineering profession more diverse and inclusive.



**DR ANNA
LAVELLE FTSE**
**AusBiotech Ltd
(Victoria)**

Dr Anna Lavelle, CEO of Ausbiotech, has played a pivotal role in biotechnology and healthcare innovation and

increased investment into the industry. Her greatest recent contribution to the innovation/technology sector has been championing and delivering the R&D Tax Incentive to fund product development and increase foreign direct investment.



**PROFESSOR
JOCELYN MCPHIE
FTSE**
**University of
Tasmania (Tasmania)**

Professor McPhie is a world leader in the application of vulcanology to the exploration for mineral deposits.

She has developed techniques to unravel the complex geology of volcanic terrains that have been adopted world-wide. As Head of Earth Sciences at the University of Tasmania, she is internationally recognised for providing high-quality volcanology education to both students and industry geologists.



**MR BARRY
MURPHY FTSE**
**Flinders University
Centre for Marine
Bioproducts
Development (NSW)**

Mr Murphy is a chemical engineer and leading industrialist who has achieved outstanding

transformative public and private sector outcomes in oil, coal, electricity, airports, rail and biofuels over more than three decades, influencing public policy outcomes. He participates actively in public policy debate on Australia's future energy supplies, greenhouse science and responses, and transport infrastructure, and chairs the Flinders' CMBD Advisory Board.



**SCIENTIA PROFESSOR DEO PRASAD
AO FTSE**

University of New South Wales (NSW)

Professor Prasad, CEO of the Cooperative Research Centre for Low Carbon Living at UNSW, is a passionate advocate of sustainable development and has demonstrated national and international leadership through his work as an architect, academic and expert with organisations like the UN Environment Program. He has served as President of the Australia New Zealand Solar Energy Society and Chair of the UN Global Civil Society Forum (Asia-Pacific).

**PROFESSOR NILS
GORAN ARNE ROOS
FTSE**
**Advanced Manufacturing
Council (SA)**

Professor Roos is one of the founders of modern intellectual capital science and a world expert in this field. He contributes in the areas of strategy, innovation management and industrial and innovation policy. He is chair of the SA Advanced Manufacturing Council, a member of the SA Economic Development Board and holds several academic positions in Australia and overseas.



**PROFESSOR
CRAIG
SIMMONS FTSE**
**National Centre
for Groundwater
Research and
Training (SA)**

Professor Simmons is recognised

for major national and international contributions to groundwater science, education and policy reform. Director of the NCGRT at Flinders University, he is one of Australia's foremost groundwater academics and has been a significant contributor to global advances in the science of hydrogeology for many years.

ATSE IN FOCUS



DR LORRAINE STEPHENSON FTSE
Founder and Principal Consultant, Lightning Consulting Services (Queensland)

Dr Stephenson is widely recognised as a leading industry expert working at

the nexus of policy, strategy and innovation across energy, climate change and sustainability. She has held senior executive roles and current Board positions and, as founder of Lightning Consulting Services, advises governments on the development and financing of low-emission technologies.



PROFESSOR JOSE LUIS TORERO CULLEN FTSE
University of Queensland (Queensland)

Professor Torero Cullen, Head of

the School of Civil Engineering at UQ, is an international leader in fire safety engineering who has influenced architectural, structural, aerospace and environmental safety practices worldwide and deeply influenced engineering education, research and practise. His influence has extended into sanitation, food security, structural, environmental and bio-engineering.



PROFESSOR ALAN TROUNSON FTSE
President, California Institute for Regenerative Medicine (USA)

Professor Trounson was the scientific force behind the development of in vitro fertilisation (IVF) and embryo biopsy as standard therapies for human infertility and inheritable monogenetic diseases. President of the CIRP, and formerly a long-term Monash University researcher, Professor Trounson led the development of the National Stem Cell Centre in Melbourne.



PROFESSOR ANTHONY WEISS FTSE
University of Sydney (NSW)

Professor Weiss, Professor of Biochemistry and Molecular Biotechnology, is an outstanding scientific

leader. He founded biotechnology company Elastagen to promote national and international technology development of his discoveries. He has an outstanding record of scientific achievement together with an impressive patent portfolio, a combination recognised with an array of national and international awards and prizes.

PROFESSOR TONY WONG FTSE
CRC for Water Sensitive Cities (Victoria)

Professor Wong, who heads the CRC, is an international thought-leader on urban water management and contributes globally to government and industry efforts in delivering sustainable and resilient urban water systems. Professor Wong's contributions as a civil engineer have forged innovative bridges between theory and practice and have won him many awards.



DR ELIZABETH WOODS OAM FTSE
Deputy Director-General, Agriculture (Queensland)

Dr Woods is recognised nationally and internationally for her leadership in innovative agricultural

research. Her commitment over 20 years has had a lasting impact on the development of new capabilities and approaches to ensure that science contributes to the profitability of Australia's farmers and addresses hunger and poverty in the developing world.



PROFESSOR XINHUA WU FTSE
Monash University (Victoria)

Professor Wu is a world-renowned metallurgical engineer who is Director of the ARC Centre of Excellence for Design in Light Metals and is making a major impact on advanced manufacturing technologies for the aerospace industry. She has established two research centres, has facilitated a start-up company and is leading the creation of a new ARC Industrial Transformation Research Hub in additive manufacturing.

ADJUNCT PROFESSOR JIMMY YUN FTSE
HG Energy & Envirotech Pty Ltd Singapore (Singapore)

UNSW Adjunct Professor Yun is Founding Director and CEO of HG Energy & Envirotech and has for 25 years been a pioneer of the development and commercialisation of technologies based on principles of process intensification and sustainability. He has successfully developed and commercialised high-gravity reactive precipitation technology that enables reductions in size of process plant of up to three orders of magnitude.



2014 FOREIGN FELLOW

PROFESSOR DENNIS LIOTTA FTSE
Emory Institute for Drug Development (USA)

Dr Liotta is the inventor behind 95 per cent of the world's prescriptions for HIV AIDS and is now collaborating to develop novel cancer drugs in Australia. Executive Director of the US Emory Institute for Drug Development, Dr Liotta is known worldwide for discovering two crucial antiviral drugs, lamivudine and emtricitabine, used in almost all HIV drugs, with annual sales exceeding \$1 billion.

His commitment to the community is reflected in his appointment to the RedR Australia (Registered Engineers for Disaster Relief) Board in 2006 and subsequent role as Chair from 2008–10.



ATSE IN FOCUS

Malcolm Kinnaird dominant in engineering and SA

The founding father of Kinhill, Mr Malcolm Kinnaird AC FTSE, has been widely acknowledged in the engineering profession and in South Australia for his vision and energy.

Mr Kinnaird was the driving force in the establishment of an engineering consultancy called Kinnaird, Hill, de Rohan and Young in Adelaide in 1960, which later became the national engineering firm Kinhill Engineers and then KBR, after being purchased by Brown & Root/Halliburton in 1997.

Mr Kinnaird (a Fellow since 1990) died in Adelaide in September, aged 80.

Dr Tom Connor AO FTSE, Director IGP Resources Vice President Technology at KBR, writes:

Of course there were many who contributed to Kinhill's success in expanding from that small beginning to become a national and international firm of high reputation. But it was certainly Malcolm's vision and energy that drove that success.

"He was a larger-than-life character who exerted great influence over the direction of the firm through the varying economic cycles of the decades since 1960. Without his wisdom and foresight in anticipating the needs for the future, and stubborn and driven insistence on kicking the goals that lay directly ahead, it is unlikely that Kinhill would have become what it became by 2000 and what it has morphed into today.

Although Malcolm had that very strong

business sense and passion, he also showed great empathy towards his colleagues throughout the business, but particularly to the young professionals embarking on their careers. He was a great supporter of the young engineer, probably reflecting on his ambitious career beginnings, and continued to go out of his way to engage and counsel past colleagues in his retirement.

For any business to grow, it needs to invest in technology, innovation and youth, and Malcolm displayed his commitment to all of that – while driving for good engineering and delivering successful projects for clients. The history of good and great projects delivered by Kinhill over those decades is testimony to his leadership, drive and character.

Malcolm will be sorely missed by those who knew him but we will all recall with great fondness so many incidents and occasions and projects for which he carried so much influence. He was a great man.

Mr Kinnaird was also a prominent figure in SA and in a number of business circles around Australia, and had played important roles on the boards of a number of Australian companies. He was acknowledged with various awards – including South Australian of the Year in 2003.

He was an inaugural appointee to the SA Engineers Hall of Fame in 2006 and Engineers Australia SA Division has named its highest project award for Engineering Excellence 'The Malcolm Kinnaird Engineering Excellence Award' in his honour.

Mr Kinnaird was known in Adelaide for constructing the original David Jones building and developing West Lakes and North Haven from swampland into residential and business districts. He was also chairman of the consortium that designed and built the Alice to Darwin railway and the accompanying port facility.

SA Premier Jay Weatherill paid tribute.

"He was a visionary who had no fear of the size of projects he would undertake,"

Mr Weatherill said. "A committed South Australian, Mr Kinnaird was a passionate advocate for our state and will be missed by all.

"Mr Kinnaird was also a great mentor to those around him and advised governments of both persuasions at a state and federal level."

Mr Kinnaird's passions included sailing and he was founder of the Cruising Yacht Club of South Australia.

ROBERT CARE NAMED 2014 PROFESSIONAL ENGINEER

Dr Robert Care AM FTSE, an Arup veteran, was named Professional Engineer of the Year at Engineers Australia's Sydney Engineering Excellence Awards 2014.

Dr Care is a Principal in the Australasia Region of Arup Group. He helped lead the



Robert Care (right) receives his award.

reform of Australia's building regulations in the 1990s and has worked on many major global railway and infrastructure projects.

From 2004–10 he was Chair of Arup Group's Australasia Region and from 2010–13 was Chair of Arup Group's UK, Middle East and Africa region.

As a member of the Arup Global Group Board from 2008–14 he held responsibility for Ethics and Sustainability and believes that real value for clients is added through sustainability.

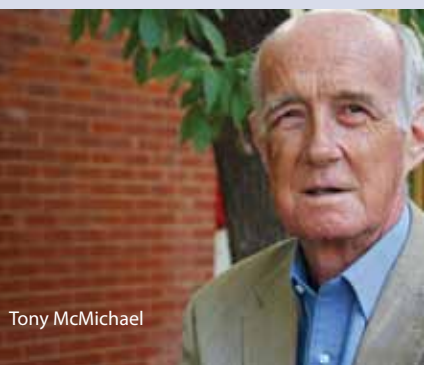
His commitment to the community is reflected in his appointment to the RedR Australia (Registered Engineers for Disaster Relief) Board in 2006 and subsequent election as Chair from 2008 to 2010.



Malcolm Kinnaird

ATSE IN FOCUS

Tony McMichael was a giant in science



Tony McMichael

Emeritus Professor McMichael AO FTSE was a champion of environmental health and became the world authority on the impact of climate change on human health.

Professor McMichael, former director of the ANU National Centre for Epidemiology and Population Health (NCEPH), was also instrumental in alerting the world to the dangers of passive smoking as well as the health impact of lead pollution, leading to a ban on lead in petrol in more than 100 countries.

Since the early 1990s, Professor McMichael was a world authority on the risks to human health from climate change, and his work advised both the World Health Organization and the United Nations Intergovernmental Panel on Climate Change (IPCC).

Professor McMichael, Adelaide-born and a Fellow since 2003, died in Canberra in September, aged 71.

ANU Vice-Chancellor Professor Ian Young AO FTSE led the tributes to Professor McMichael, describing his death as a great loss to the university and the world of science.

"Tony was a fearless and tireless champion of public health, whose work has improved the lives of millions of people around the world," Professor Young said.

"He was a giant in the field of epidemiology, who cared about people and inspired the best from his colleagues and students. He will be dearly missed."

Professor McMichael studied medicine in Adelaide and completed a PhD in epidemiology in 1972, before working as an academic and researcher at the University of North Carolina.

For 10 years from 1976 he headed CSIRO's epidemiology research program, then was Professor of Occupational and Environmental Health at the University of Adelaide (1986–93) before serving as Professor of Epidemiology at the London School of Hygiene and Tropical Medicine from 1994 to 2001.

Professor McMichael was Director at NCEPH (2001–07), and he was awarded a prestigious Australia Fellowship by the National Health and Medical Research Council in 2007.

Professor McMichael published more than 300 peer-reviewed papers and three major books, including his 1993 book *Planetary Overload: Global Environmental Change and Human Health*, which outlined the threats to health from climate change, ozone depletion, land degradation, loss of biodiversity and the explosion of cities.

He also served on the Science Advisory Panel to the former Climate Change Commission, and was an Honorary Professor of Climate Change and Health at the University of Copenhagen.

He was a founding Board Member of The Climate Institute and passionate about the need for independent organisations such as The Climate Institute. Long before co-founding this institute, in 2005, he was a founder of the discipline of public health and pioneered the links between climate change, health and the human story.

He was a passionate believer in quality research and education, and was described as "the most gentle of men, whose profound humanity and integrity endeared him to those who met him, and whose searing intellect brooked no fools or favours".

PHILIP LAFFER: WINE INDUSTRY LIFE MEMBER

Mr Philip Laffer AM FTSE has been named Life Member of the Australian Wine Industry – the first recipient of the new national award.

Administered by the Winemakers' Federation of Australia, the Life Member of the Australian Wine Industry Award recognises outstanding leadership and contribution to the nation's wine industry, going over and above an individual's career achievements.

Mr Laffer has been a Fellow since 2004.

The descendent of vineyard owners and the son of an agricultural scientist, Mr Laffer has played a significant part in making Australian wines what they are today. Working in trade, marketing, winemaking, viticulture and management over the years, including as one of the architects of Jacob's Creek, he has given a lot to the industry.

When his career began, Australian table wine was just finding its feet.

"How much things have changed," Mr Laffer says, "but we also must continue inspiring the viticulturists and oenologists of tomorrow to keep industry on its game."

"We need to keep attracting talented and driven people to the wine industry, people who are passionate about their wines, their brands and the future of an important and diverse Australian industry."



Philip Laffer

"Receiving this award is an honour and I am humbled and proud to be recognised by my industry in this way."

Mr Laffer graduated from Roseworthy

College and worked progressively at Lindeman's Holdings as winemaker, technical director, head of marketing/sales and then executive director (1963–90). From 1990 to 2012 he worked at Orlando Wyndham, Pernod-Ricard Pacific and Premium Wine Brands.

From 2013, Mr Laffer has continued in the industry as a winemaking and viticulture consultant in Australia, China and Argentina.

He has served on the Winemakers' Federation of Australia Board, including as Vice-President, as well as President and Vice-President of the South Australian Wine Industry Association.

Other senior advisory roles have included those with the Australian Wine and Brandy Corporation (Wine Australia's predecessor), the Australian Wine and Research Institute, the Grape and Wine Research and Development Corporation, the Royal Agricultural and Horticultural Society of SA, the CRC for Viticulture and the NSW Wine Industry Association.

ATSE IN FOCUS

Rachel Makinson changed our understanding of wool

At the end of World War II Australia was riding on the sheep's back – but the industry knew very little about the physics of wool, a disadvantage in the face of new synthetic fibres. CSIRO launched its Division of Textile Physics and recruited a young Englishwoman who was to become a world expert.



Rachel Makinson

That expert, Dr Rachel Makinson AM FTSE, a Fellow since 1981, died in Sydney in September, aged 97.

"Next to nothing" (her words) was known in 1945 of the physical properties of wool fibres and the processes of felting and shrinkage. Shrink-proofing by chlorination (the only known method) damaged the fibre and in any case was not well understood. Dr Makinson's life work was to systematically examine the underlying physics of wool fibres and their microscopic interactions.

While her work was pure research, she wrote with a close eye to its practical uses. Her published work became canon in the field, but some work she was not allowed to publish – in the 1950s she had found that the addition of a small proportion of the right synthetics to wool could produce a superior product, but this ran against the 'wool only' policy of the powerful Australian Wool Board, which was not eased until 1971.

Dr Makinson became a world authority on the friction, felting and shrink-proofing of wool. In 1970 she took her PhD from Cambridge University. In 1971 she became a Senior Principal Research Scientist at CSIRO, and in 1977 its first female Chief Research Scientist. In 1979 she became Assistant Chief of Division, the first woman to achieve that rank in CSIRO.

Kathleen Rachel White was born in 1917 near London. She secured a scholarship to study physics at Cambridge University, anticipating a career in X-ray crystallography; however, she had met and married an Australian postgraduate physicist at

Cambridge, Richard E.B. (Dick) Makinson.

Their interests intersected both professionally and politically. She was in the Cambridge University Socialist Club and had been active in support of Indian independence. He had travelled in Europe in 1937 and had seen the Nazi regime in power.

Back in Australia, he became a lecturer in physics at the University of Sydney, but Australia had rigid barriers against the employment of women – especially if married – in most professions. However, the war had eroded some of the barriers to employment of women, particularly in technical fields, and Dr Makinson tutored several cohorts of RAAF airmen in the rudiments of radio physics as a precursor to radar training. She secured a position with CSIR (forerunner of CSIRO) in the new field of wool research. As married women were denied permanency, she was to remain a temporary employee for some 20 years, with annual reappointment by special Ministerial permission.

Dr Makinson held socialist and humanist beliefs throughout her life. She also had a longstanding interest in Aboriginal Australia and was active around the 1967 referendum and later in other forms of support.

From the early 1960s Dr Makinson's energies were channelled into the struggle for equal pay for women through the CSIRO Officers Association, which she helped to form.

Obituary material contributed by Dr Makinson's son, Bob Makinson.

BRIAN INGLIS WAS AN AUTOMOTIVE LEGEND

Sir Brian Inglis AC FTSE spent his whole working life with the Ford Motor Company, starting with Ford Canada (1949–51) and ending as MD and Chairman of Ford Australia and President of Ford Asia-Pacific. He also found time to Chair AMCOR, Newcrest Mining and Optus, and serve on the Boards of Mayne Nickless and Australian Paper, as well as being awarded a Legion of Honour (France's highest decoration) for his World War II RAAF exploits.

Sir Brian, a Fellow for more than 30 years and a former Treasurer of the Academy, died in Victoria in September 2014, aged 90.

In 1942, soon after his 18th birthday, he enlisted in the Royal Australian Air Force and was sent to Britain to fly Spitfires with No. 453 Squadron. His most vivid memory of the war, which he recalled when awarded the French honour in 2005, was the D-Day invasion, when his squadron flew cover for the invasion fleets heading to France.

After the war, Sir Brian graduated from the University of Melbourne with a BSc in metallurgical science in 1948 before starting his Ford career.

Appointed Manufacturing Engineering Manager in 1951, he supervised the modernisation of Ford's Geelong plant in 1957–58 before establishing the Broadmeadows plant in Melbourne.

He was subsequently Director of Manufacturing and Supply at Ford before being appointed MD in 1970, leading the introduction of automation and technological upgrades in welding, painting and vehicle production and more obvious external aspects such as styling, vehicle test

tracks, engine test laboratories, durability simulation facilities and a stress analysis laboratory.

In 1981, when he took over Ford Asia-Pacific, he had responsibility for manufacturing facilities in Australia, New Zealand, Taiwan and the Philippines; assembly plants in Malaysia, Indonesia, Thailand and Japan; and sales outlets in Korea, Hong Kong, India, Singapore and Fiji.

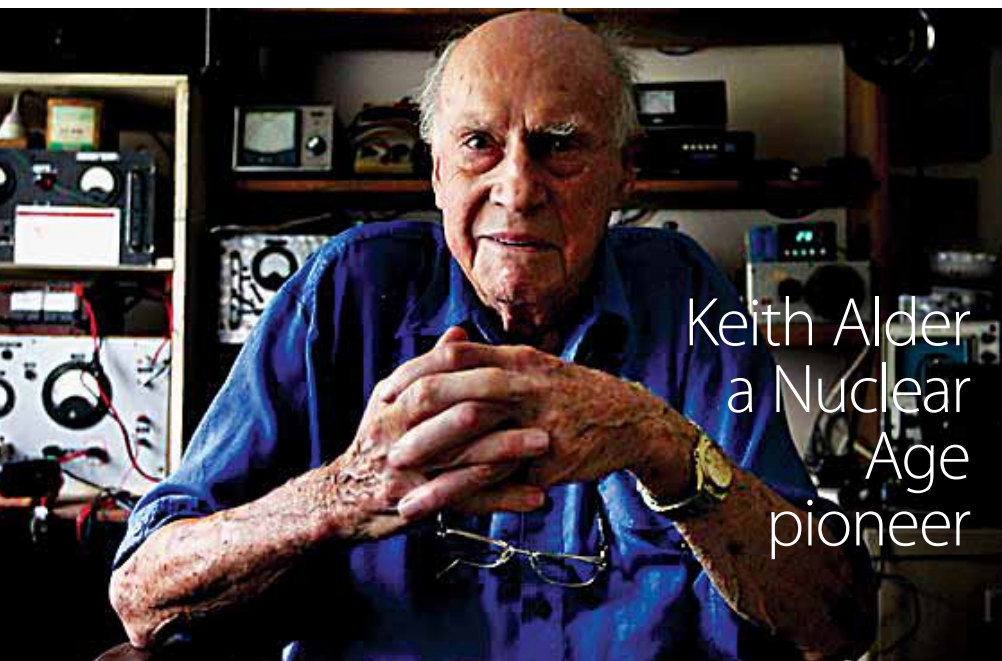
His nomination citation, signed by Sir John Holland, Mr Brian Loton, Sir Ian McLennan and Dr Howard Worner – all ATSE legends – notes he had exercised "outstanding leadership" in Australia's auto industry and "been responsible for introducing modern engineering practices, including highly sophisticated robot systems, into manufacture".

His expertise was acknowledged with the award of the James Kirby Award by the Institute of Production Engineers (1979) and the Kernot Memorial Medal by the University of Melbourne in the same year.



Sir Brian Inglis

ATSE IN FOCUS



Keith Alder
a Nuclear
Age
pioneer

Keith Alder

Keith Alder was a nuclear warrior for most of his working life – always against the odds.

The subhead on the cover of his 1996 book *Australia's Uranium Opportunities* says it all – “how her scientists and engineers tried to bring her into the nuclear age but were stymied by politics”.

A metallurgist and former head of the Australian Atomic Energy Commission's Lucas Heights Research Establishment (1962–70), Mr Alder AM FTSE died in Sydney in September, aged 93. He had been a Fellow since 1977.

After completing his MSc at the University of Melbourne in 1944, Mr Alder worked for a year as a metallurgist for the Tungsten Plant Ammunition Factory in Footscray before serving a two-year lectureship in metallurgy at Newcastle Technical College.

From 1946–48 he was a senior scientific officer for the Ministry of Supply Atomic Weapons in Woolwich, London. He returned to Australia and was appointed senior lecturer in physical metallurgy at Melbourne University (1952–53). The Atomic Energy Research Establishment in Harwell, England, employed Mr Alder from 1954–57 and in 1955 he was appointed Head of the Metallurgy Section at the Lucas Heights Research Establishment run by the Australian Atomic Energy Commission (AAEC).

He remained with the AAEC at Lucas

Heights for more than 20 years, taking on many roles including Director, Head of the Development Group, Head of the Nuclear Science and Technology Branch and was General Manager 1976–82.

He was a Fellow of the Institute of Metallurgists and the Institution of Radio and Electronics Engineers Australia.

Keith Alder's battle is captured in an article by Cheryl Jones published in *The Australian* last year, which notes that Australia's first nuclear facility, the Lucas Heights High Flux Australian Reactor (HIFAR), was functioning as early as 1958.

“The HIFAR was built to test materials for use in a future nuclear power plant. Alder was one of a few elite scientists and engineers sent by the Australian Atomic Energy Commission to Harwell in Britain to learn how to harness the awesome power of the atom to generate electricity. They were to bring the arcane knowledge home to set up a nuclear power research program. But science would meet politics, and a planned station at Jervis Bay on the NSW south coast never materialised. There are still no plans for a nuclear power plant in Australia.”

Mr Alder was heavily involved in the Jervis Bay project, proposed by the Federal Government as a 500MWe nuclear power station, to be built on Commonwealth territory and to feed the NSW electricity grid. It would have been Australia's first nuclear power plant, and was the only proposal yet to have received serious consideration.

The proposal, approved in 1969, was killed two years later when pro-nuclear Prime Minister John Gorton was ousted by his own government in favour of Sir William McMahon.

Mr Alder, who watched the Jervis Bay reactor begin to take shape, remembered the cancellation bitterly and remained convinced that the decision not to go nuclear was wrong.

“I think it was a tragic mistake,” Mr Alder told Reuters in 2001.

He maintained his belief that Australia will eventually turn to nuclear power to keep up with the nation's growing population and burgeoning appetite for energy.

“It's inevitable. Down the track, if we don't go nuclear we die in the cold and the dark. It is as simple as that – ask California at the moment what they think.”

HELEN GARNETT ON GRDC BOARD

Dr Helen Garnett PSM FTSE, Director of Sugar Research Australia and Chair of Delta Electricity, has been appointed to the Board of the Grains Research and Development Corporation (GRDC).

Dr Garnett has been appointed for three years and joins Dr Jeremy Burdon FTSE on the GRDC Board.

Announcing the new Board members, Agriculture Minister Barnaby Joyce said they would guide the investment and research efforts of the GRDC to generate the best return for grower levies and would play an important role in investing grower and taxpayer funds to ensure a profitable and sustainable grains industry into the future.

Dr Garnett is a former Executive Director of ANSTO, was inaugural Vice-Chancellor of Charles Darwin University (2003–08) and is a Professor Emerita of the university.

She is a director of three bioscience entities, the Australian Centre for Plant Functional Genomics, the Australian Biosecurity Intelligence Network and the Grape and Wine Research and Development Corporation and is a Director of the Crawford fund.



Helen Garnett

ATSE IN FOCUS

Ann Henderson-Sellers named global woman of influence

Professor Emerita Ann Henderson-Sellers FTSE has been named among 10 leading Australian women of influence by judges of *The Australian Financial Review* (AFR) and Westpac 100 Women of Influence Award.

Professor Henderson-Sellers headed the Global category, one of 10 categories in the Award, which was won overall by

Sex Discrimination Commissioner and Human Rights Commissioner Ms Elizabeth Broderick.

Ms Kathryn Fagg FTSE, Chair of the Academy's Industry and Innovation Forum and a Board Member of the Reserve Bank of Australia, was named among the 10

finalists in the Board/Management category.

Professor Henderson-Sellers was recognised for her role as an international leader in climate science, authoring 20 books and more than 400 articles, and championing female communicators in her work on climate change over 40 years.

"We know that when women and girls gain credibility and are given a voice, many aspects of life go better," she told AFR.

"We do know what to do. We all just need more encouragement to do it.

"This award is one great route," she said.

Professor Henderson-Sellers was the Director of the World Climate Research Program, based in Geneva, in 2006 and 2007 and was the Director of the Environment Division at ANSTO from 1998 to 2005. She was the Deputy Vice-Chancellor (Research & Development) of The Royal Melbourne Institute of Technology from 1996–98. Prior to this she was the founding director of the Climatic Impacts Centre at Macquarie University.

She was elected a Fellow in 2000.

Professor Henderson-Sellers is an international leader in climate science. She has championed the scientific need for action

to mitigate and adapt to climate change for more than 35 years. She holds an Australian Research Council Professorial Fellowship in the Department of Physical Geography of Macquarie University.

Professor Henderson-Sellers has been an Earth Systems scientist all her life spearheading the description and prediction of the influence of land-cover and land use change on climate and human systems. She has a BSc in mathematics, undertook her PhD in collaboration with the UK Meteorological Office and earned a DSc in climate science in 1999.

She was awarded the Centenary Medal of Australia for Service to Australian Society in Meteorology in 2003 and is an elected Fellow of America's Geophysical Union and the American Meteorological Society.

In the 1990s she served as a Council member of the International Council of Science's International Geosphere-Biosphere Program (IGBP) and as a Convening Lead Author for the Second IPCC Assessment Report. She chaired a national investigation into Women in Science, Engineering and Technology in the 1990s and served on Australia's Science and Technology Council, chaired the Australian National Committee for Climate and Atmospheric Sciences and has been a member of the Greenhouse Science Advisory Committee.

Professor Henderson-Sellers served as the President of International Association of Meteorology and Atmospheric Sciences' International Commission for Climate from 1991–95.

GORDON BELL WINS TOP IEEE AWARD

Foreign Fellow Mr Gordon Bell, known as "the father of the minicomputer", has been named the recipient of the 2014 IEEE Computer Society Seymour Cray Computer Engineering Award for his work in designing computer systems that significantly changed high-performance computing.

Elected to the Academy in 1999, Mr Bell – a researcher emeritus in the Microsoft Research Silicon Valley Laboratory – was recognised "for his exceptional contributions in designing and

bringing several computer systems to market that changed the world of high-performance computing and of computing in general, the two most important of these being the PDP-6 and the VAX-11/780".

He was presented with his award in November in New Orleans.

One of IEEE Computer Society's highest awards, the Seymour Cray Computer Engineering Award is presented in recognition of innovative contributions to high-performance computing systems that best exemplify Cray's creative spirit. The award consists of a crystal memento, a certificate, and a \$10,000 honorarium.

An early employee of Digital Equipment Corp. (DEC) from 1960 to 1966, Mr Bell designed several of its PDP machines and later became Vice President of Engineering from 1972–83, overseeing the development of the VAX computing environment.

Mr Bell also founded Encore Computer, one of the first shared-memory, multiple-microprocessor computers to use the snooping cache structure. He was a founding member of Ardent Computer in 1986, becoming Vice President of Research and Development in 1988, and remained until it merged with Stellar in 1989, to become Stardent Computer.

Mr Bell is a Fellow of IEEE, the American Academy of Arts and Sciences, American Association for the Advancement of Science, and a member of the US National Academy of Engineering and National Academy of Science.



Ann Henderson-Sellers



Gordon Bell

ATSE IN FOCUS

Don Brown influenced varied businesses



Don Brown

Dr Donald Brown influenced many of Australia's development in minerals, electricity generation and distribution and satellite communications – as well as serving as a Director of a number of public companies.

A Fellow for 30 years, he died in Sydney in October, aged 90.

He was a former Deputy General Manager and Director of CSR, former Chairman of the NSW Electricity Commission and former Chairman of Aussat (the Australian Satellite Company).

A chemist by training, he spent most of his working life with CSR until his retirement in 1980. He was Head of Production at CSR's Refinery Division in 1952 and was then General Manager (1958–64).

He was heavily involved in CSR's diversification in the 1960s and 1970s into major resource projects in minerals and energy. Between 1965 and 1973 he was Managing Director of Pilbara Iron Ltd and then Deputy General Manager of CSR (1972–80 and Executive Director of CSR (1973–80).

During this period he was a Director of Weeks Petroleum Ltd and Western Collieries Ltd; a Member of the Executive Council of the Australian Mining Industry Council; and Chairman of Gove Alumina Ltd, Buchanan Borehole Collieries Ltd, Port Waratah Coal Services Ltd, Pilbara Iron Ltd, AAR Ltd and CRS Chemicals Ltd.

He was subsequently Chairman of the Electricity Commission of NSW (1982–87) and Aussat (1990–92).

Dr Brown's Fellowship citation notes that in his roles within CSR, he was responsible for the development of some of the nation's key resources "which required the marshalling of extensive technological and commercial skills, both in Australia and overseas".

He played a key role in organising and bringing to fruition the establishment of Port Waratah's technologically advanced coal blending, handling and ship-loading facilities at Newcastle – the first large, privately owned

coal export complex in NSW.

He also led CSR's entry into the coal industry with the purchase and subsequent development of the Buchanan Borehole Collieries in the Hunter Valley into two underground and two open-cut mines, winning strong markets in both Japan and Korea for its coking coal.

ANOTHER HONOUR FOR PAUL ZIMMET



Paul Zimmet

Professor Paul Zimmet AO FTSE, Director Emeritus at the Baker IDI Heart and Diabetes Institute, has won the Outstanding Achievement in Diabetes Award, presented by Diabetes Australia-Vic (DA-Vic).

Professor Zimmet is co-chair of the National Diabetes Strategy Advisory Committee, Honorary President of the International Diabetes Federation and head of the WHO's Collaborating Centre for the Epidemiology of Diabetes Mellitus.

Professor Zimmet is influential both nationally and internationally in the field of diabetes. Last year he oversaw the World Diabetes Congress scientific program – for the largest health conference ever held in Australia.

He led the first national diabetes and obesity study in 2000 – the Australian Diabetes, Obesity and Lifestyle Study (AUSDIAB) – which, with a follow-up study in 2012, is still the Australian benchmark study in the field.

GUS HALLEGRAEFF WINS YASUMOTO AWARD

Professor Gustaaf Hallegraeff FTSE, from the Institute for Marine and Antarctic Studies (IMAS) of the University of Tasmania, has been awarded the prestigious Yasumoto Award for

his lifetime achievements in harmful algal bloom research

The Award was presented during the 16th International Conference on Harmful Algae (ICHA) in Wellington in October – only the seventh award made and the first time it has been awarded to a southern hemisphere recipient.

Professor Takeshi Yasumoto, who in 2004 received the Japan Imperial Prize for his work on microalgal toxins, presented the Award – a wooden carving of the chain-forming toxic dinoflagellate *Gymnodinium catenatum* – while Dr Chris Bolch, one of Professor Hallegraeff's first PhD graduates, read out the citation.

Starting in 1986, Professor Hallegraeff and his collaborators discovered the dinoflagellate in Tasmanian waters, characterised its paralytic shellfish toxin profile and life cycle, instigated the Australian Shellfish Quality Assurance Program (ASQAP) and ultimately linked the organism to ship ballast water discharges.

He helped draft the 2004 International Maritime Organisation's (IMO) ballast water



Professor Hallegraeff's award

convention which is expected to come into force in 2015.

Accepting the award, he acknowledged his 35 PhD students, eight of whom presented talks at the Wellington conference, which was attended by 408 participants from 41 countries.

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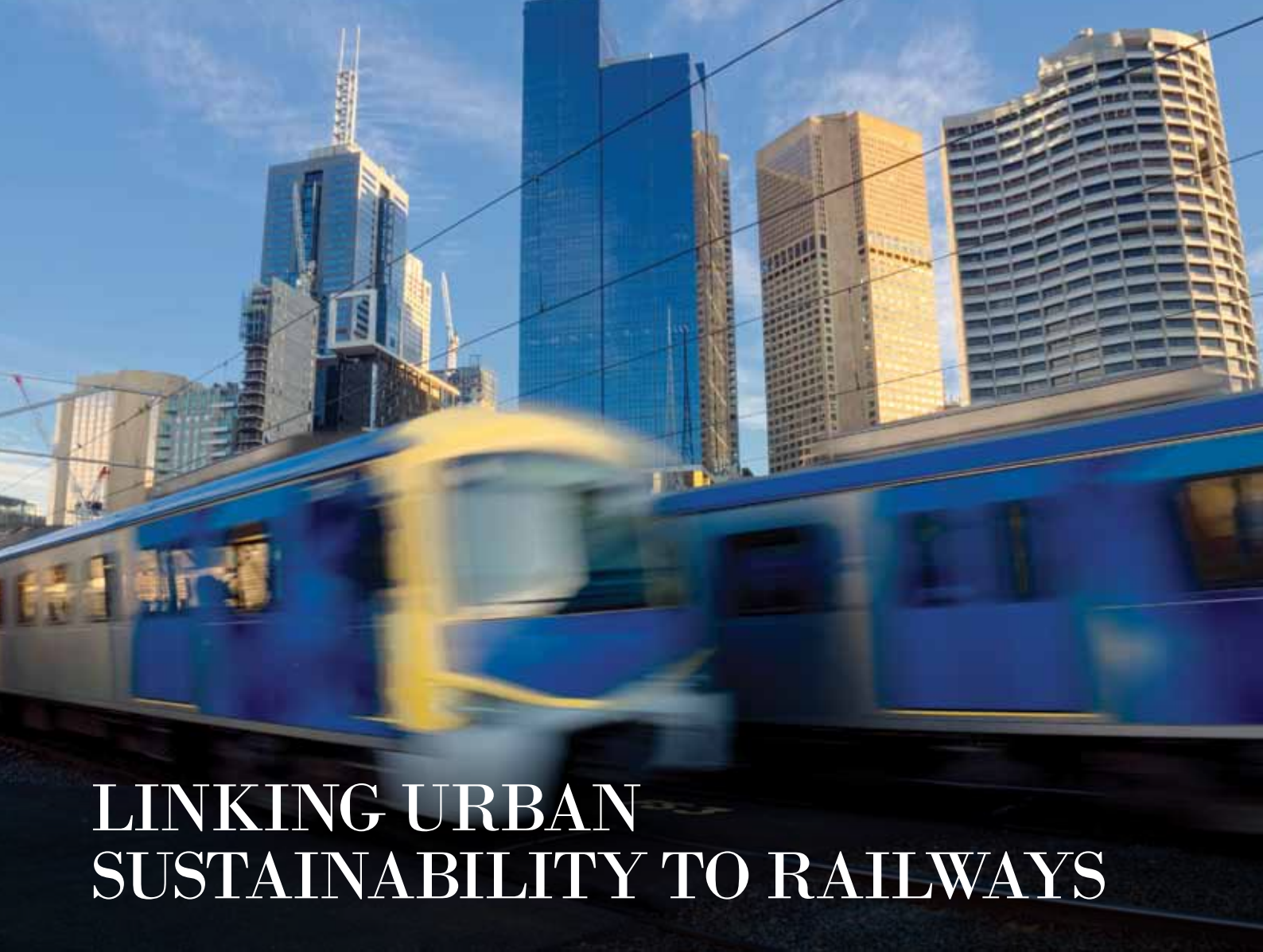
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LINKING URBAN SUSTAINABILITY TO RAILWAYS

The high level of car-based travel in Australian cities has significant costs, including greenhouse gas emissions, road congestion, and land dedicated to roads and parking lots.

Researchers from The University of Queensland's School of Geography, Planning and Environmental Management are finding ways to effectively reorient our cities around railways to make better use of existing infrastructure and increase urban sustainability. This research is led by Associate Professor Glen Searle and Dr Sébastien Darchen.

The approach – called transit oriented development – is based on locating higher density residential developments, offices, shops and other travel destinations within walking distance of a rail station to increase the overall use of rail and decrease reliance on cars.

The research aims to identify possible rail station precincts and inform the decision making of state governments and city councils about which precincts should have planning and development priority.

UQ's School of Geography, Planning and Environmental Management is focused on discovering new knowledge and finding practical solutions to the big issues that will affect us all; such as urbanisation, population growth, conservation and resource management. School research staff and students are at the forefront of major international initiatives to better manage our natural and built environments. More information is available at gpem.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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