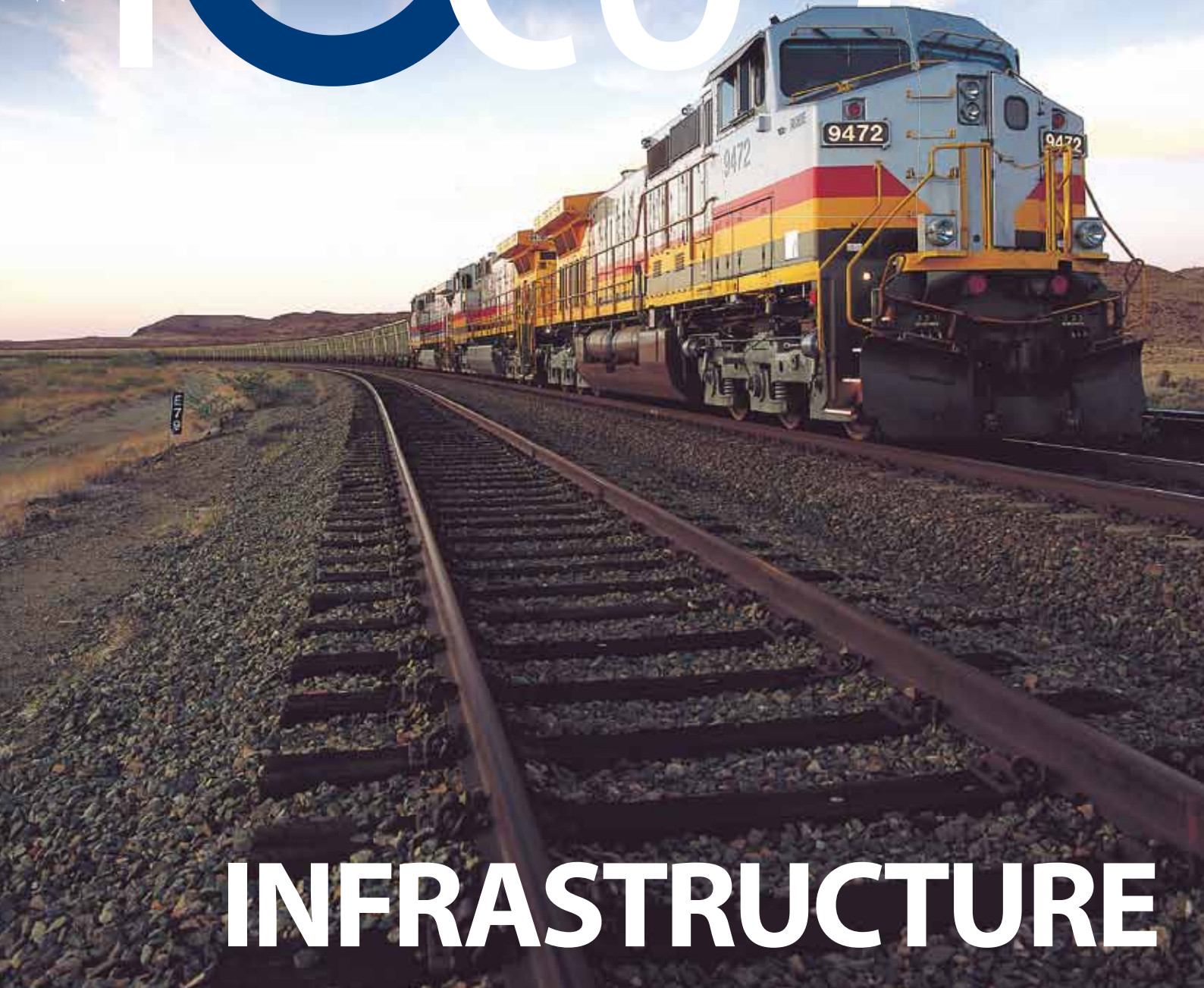




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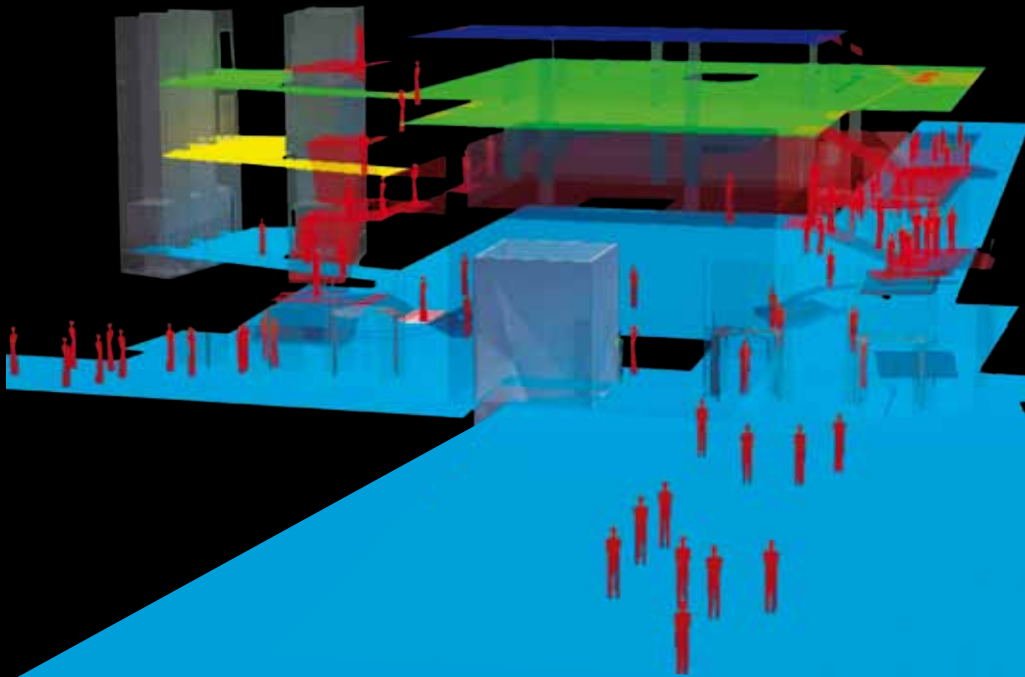
NUMBER 157
AUG / SEP 2009



INFRASTRUCTURE

SHAPING UP FOR THE 21st CENTURY

Contributors discuss the Federal stimulus packages and the Budget impact on infrastructure – and getting our infrastructure right for the century ahead



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Stimulus packages working, but don't address major infrastructure issues

By Richard Kell

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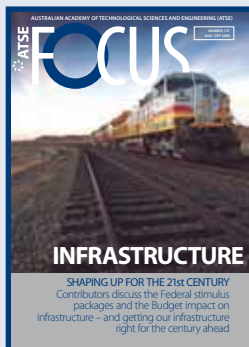
Infrastructure needs multi-layered partnerships and robust coordination

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Achieving the best options for electricity distribution

By Martin Thomas



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Photo: Rio Tinto

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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 pieces on topics of national interest, particularly the Academy's key interest areas – climate change, water, energy and education – will be considered for publication. Items between 800 and 1500 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 **30 September 2009**.

ATSE is an independent body of eminent Australian engineers and scientists established to promote the application of scientific and engineering knowledge to practical purposes. ATSE *Focus* is produced to serve this goal.

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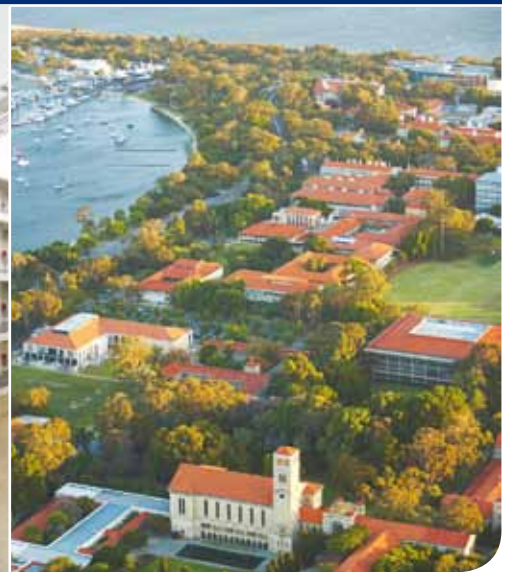
ABN 58 008 520 394

Print Post Publication No 341403/0025

ISSN 1326-8708

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

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**THE UNIVERSITY OF
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Stimulus packages working, but don't address major infrastructure issues

Multi-billion dollar arterial road or rail projects have long lead times, 18 months or more, and require property acquisition, planning and environmental impacts to be addressed



By Richard Kell

richard.kell@cardno.com.au

The fiscal stimulus packages which comprise the Federal Government's response to the Global Financial Crisis (GFC) were announced in three packages:

- **December 2008:** \$4.7 billion Nation Building Package
- **February 2009:** \$42 billion Nation Building and Jobs Plan
- **May 2009-10 Budget:** \$22 billion investment in infrastructure, including broadband.

The December 2008 and February 2009 Stimulus Packages allocated \$23.45 billion directly to infrastructure (see table). The Government's priorities within the two stimulus packages were largely directed to projects which:

- could be commenced immediately – the term 'shovel ready' is used;
- involved maximum opportunity for employment creation, including in regional/rural and lower socio-economic areas; and
- would have a wide community benefit.

Relatively small building projects (of the order of \$1 million or less) within existing schools and road safety projects fitted these criteria, unlike, for instance, major arterial road or rail projects, which require long lead times and concentrate expenditure to cities and coast. Such larger projects were addressed under the May budget.

The \$43 billion broadband network provision is additional to the above figures. Tax concessions for small businesses, R&D credits, investment allowance and extension of the First Home Owners Boost were further fiscal measures in the package, with the same objectives.

These measures raise a number of questions:

1 Will the public receive long-term benefits? The answer would seem to be yes, notwithstanding some inevitable unevenness and poor decisions. The fact is that every one of Australia's 9540 schools will get a new building or up-

grade of some kind within three years. The community clearly derives benefits from school buildings, road safety improvements and low-cost housing.

2 Is value for money being achieved? My observation is that adequate controls are in place for value to be achieved, certainly in the NSW managing contractor delivery model.

3 Are the Government's objectives being achieved? Again, yes. Works are already under way; employment throughout the building industry, which had weakened substantially, has certainly picked up and is now strong.

Stimulus Package allocations, December 2008 and February 2009

| | December 2008 (\$ billion) | February 2009 (\$ billion) | May 2009 Budget (\$ billion)* | Total (\$ billion) |
|-------------------------------|-------------------------------|-------------------------------|----------------------------------|-----------------------|
| ENGINEERING | | | | |
| Rail | 1.20 | | 4.60 | 5.80 |
| Road black spots | 0.25 | | | 0.25 |
| Boom gates | | 0.15 | | 0.15 |
| Roads – council | | 0.15 | | 0.15 |
| Roads – highways | 0.71 | | 3.40 | 4.11 |
| Clean energy (CCS, solar etc) | | | 4.89 | 4.89 |
| TOTAL | 2.16 | 0.30 | 12.89 | 15.35 |
| PUBLIC BUILDINGS | | | | |
| Schools | | 14.70 | | 14.70 |
| Social housing | | 6.40 | | 6.40 |
| Defence housing | | 0.25 | | 0.25 |
| Universities/TAFES | 1.60 | | 2.60 | 4.20 |
| Hospitals and health | | | 3.20 | 3.20 |
| Community projects | | 0.50 | | 0.50 |
| TOTAL | 1.60 | 21.85 | 5.80 | 29.25 |

* Broadband provision is excluded

4 Was the expenditure in accordance with a longer-term plan or justified by economic analysis? It would appear not, but the objectives of maximum employment per dollar, a wide geographic spread and immediate commencement were not conducive to strategic planning.

5 Were there alternatives? Yes – and these are discussed below.

Engineering infrastructure

There is a view that the stimulus funds would have been better spent on Australia's ailing and ageing engineering infrastructure.

The definitive evaluation of Australia's engineering infrastructure is undertaken by Engineers Australia (EA) and published as an Infrastructure Report Card (1999, 2001, 2005 and 2010 [planned]). The surveys and ratings are available on the EA website (www.engineersaustralia.org.au).

In 2005 EA rated Australia's infrastructure as only "C+ – Adequate", which equates to "major changes required" in respect of condition, committed investment, regulatory compliance and planning processes in order to be fit for purpose. Further, EA stated that:

- significant parts of Australia's infrastructure are ageing;
- current planning and political processes do not provide the necessary long-term focus; and
- current funding commitments are either inadequate or are yet to be identified.

While the situation will have been improved and is at least recognised politically by the current Government's Infrastructure Australia initiative, the EA 2005 Report Card comments remain largely relevant.

EA also confirmed that "there is a statistically significant positive relationship between investment in road and other infrastructure and private sector input" and "additional investment in roads would yield annual increases in GDP".

Treasury has recently drawn the same conclusions in respect to GDP in relation to the stimulus packages, and has also estimated that the \$22 billion stimulus expenditure will support about 15,000 jobs annually.

Thus, there is clear justification for major increases in funding for engineering infrastructure in all sectors, but particularly in road and rail.

Why then was stimulus expenditure focused on a very large number of small buildings, road safety provisions and community works? The answer lies in the Government's objectives noted above.

Multi-billion dollar arterial road or rail projects have long lead times, 18 months or more, and require property acquisition, planning and environmental impacts to be addressed – so the benefits on employment would not be realised for some years. Such large projects also concentrate the expenditure.

Compared with this, the 'shovel ready' buildings and black-spot treatment, for instance, could circumvent planning processes and be commenced within two to three months of the initial announcement. Furthermore, it is estimated that the type of work generated by the stimulus package creates perhaps two to three times more jobs than large infrastructure projects.

Also, it should not be overlooked that there has long been a dearth of effective planning and prioritising in most infrastructure sectors in Australia. This point is identified in the EA study and was a conclusion drawn from the ATSE 2006 Annual Symposium on Infrastructure (see www.atse.org.au/index.php?sectionid=883).

For example, the Sydney rail system has suffered from several major changes of planning in the past two years, with projects announced then cancelled.

National Partnership Agreement

The stimulus measures are being implemented by the states and territories, under a formal agreement with the Commonwealth titled The National Partnership Agreement on the Nation Building and Jobs Plan. This is aimed at achieving timely and effective delivery of the packages.

The Agreement imposes a number of conditions on the states:

- states to establish monitoring arrangements;
- Treasury will establish expenditure and output benchmarks;
- states to report quarterly;
- sanctions apply where states fail to meet expenditure targets – that is, a 'use it or lose it' condition; and
- the Commonwealth has appointed a Co-ordinator General to oversee implementation.

Standard designs for school halls, gyms and libraries are being utilised, which enhances cost control. Engineering is required for site-specific features such as foundations, services and groundworks. Construction commenced on schedule on stimulus package works in June 2009.

The urgency with which much of the early stimulus funds has been spent (or will need to be spent) by the states under the 'use it or lose it' model means that:

- many are using tougher contracts, and are not willing to negotiate, getting much faster to the 'take it leave it' ultimatum; and
- each state is rolling out the funds in a different way (NSW is using a Managing Contractors model, other states individual contracts, etc.), which means even more duplication and lack of coordination and strategy.

Most of the 'shovel ready' projects to date (especially BER/schools) will be reasonably short-lived (small projects) so it is important that the big spend on priority infra-



structure projects (as allocated by Infrastructure Australia) is rolled out quickly, albeit with probity and rigour. There is a need for coordination of planning responses and harmonisation and streamlining of contractual and procurement processes to expedite this important pipeline work.

Although it is early days, it does appear that the December 2008 and February 2009 stimulus packages for infrastructure are achieving the Government's planned objectives of rapid delivery of projects beneficial to the community (schools, low-cost housing, road safety) combined with jobs creation.

Treasury has assessed a positive impact on GDP. The construction sector has regained confidence and employment has strengthened significantly.

No doubt some mistakes will be made (and be publicised) in the selection of projects, but this represents a small component of a very big program.

It is probable that expenditure on larger engineering infrastructure would not have achieved these outcomes, certainly not in respect to timeliness.

The states are working under stringent controls, nevertheless there is a wide variance in the implementation

models adopted, and the harmonisation aspect should be addressed.

It is essential that the immediate stimulus packages should transition smoothly to the more strategic benefits achievable from essential upgrading of Australia's major engineering infrastructure. There is commitment in the budget for this to happen and Infrastructure Australia has been tasked and is proceeding with the planning/prioritising of major projects. ◀

RICHARD KELL AM FTSE is a civil engineer who has spent his working life as a consulting engineer and project manager in infrastructure engineering, as Managing Director and Chairman of Cardno Pty Ltd (and its predecessors), the significant Australian/international engineering consultant. He remains a director of Cardno International. He has specialised in bridge, road, marine and building projects in Australia, PNG, Malaysia, Abu Dhabi, Indonesia, Solomon Islands and Vietnam, and continues as project director on overseas projects. He is Past President (2003-05) of the International Federation of Consulting Engineers (FIDIC). He is an Honorary Fellow of Engineers Australia and recipient of John Connell Medal for Structural Engineering 2000 and an Australian Centenary Medal in 2003.

Long lead times for major projects don't fit the stimulus packages' priorities.

Letters to the Editor

ATSE *Focus* welcomes letters from readers in response to articles. Please keep letters brief to enhance publication prospects. Longer letters may be run as contributed articles. Please address to editor@atse.org.au



A sharper focus

The Monash Centre for Electron Microscopy

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at Newcastle, NSW.

Infrastructure needs multi-layered partnerships and robust coordination

The domestic freight task has doubled in size over the past 20 years – with growth averaging 3.5 per cent a year. This trend is likely to continue into the future



By Mike Mrdak and Mike Taylor

mike.mrdak@infrastructure.gov.au michael.taylor@mdba.gov.au

Getting our resources to market efficiently and seamlessly will be a key to Australia's global competitiveness in the 21st century. Productivity of our supply chains will come not just from investment in our rail lines, road and ports, but – just as importantly – planning, regulatory and governance reforms, and innovation to remove current restrictions and avoid bottlenecks building up in the future.

The challenge for infrastructure and transport is to ensure that capacity constraints to growth of exports that have occurred in the past are not repeated.

The Reserve Bank of Australia has recently revised its growth forecasts and expects to see a rise in gross domestic product in 2009. Market expectations are that the demand for Australia's resources will be restored within possibly the next 18 months and that Asian markets are likely to bounce back strongly.

The domestic freight task has doubled in size over the past 20 years – with growth averaging 3.5 per cent a year. This trend is likely to continue into the future, albeit with slightly slower growth, of about 3 per cent a year – a doubling over the 25 years from 2005 to 2030. Australia's projected resource commodity export growth (particularly

iron ore and coal), in response to China's expansion and continued demand from Japan and Korea, will underpin much of the growth in domestic rail freight activity.

Announced and prospective coal-mining capacity expansion plans could see up to 280 million tonnes added to total annual production capacity by 2015, a 67 per cent increase over 2007-08 raw black coal production (417 million tonnes), with scope for further expansion.

Planned capacity expansion at BHP and Rio Tinto's existing iron ore mining operations, scale-up of the Hope Downs joint venture and Fortescue Metals iron ore output, and the successful establishment of a host of mid-tier iron ore producers has potential to triple existing iron ore output (approximately 300Mt in 2006-07) shortly after 2015.

As a large continental island, Australia's ports are critical to supplying resources markets, both domestic and overseas.

Rail is highly efficient for moving the massive bulk loads involved. As new reserves of resources are developed, much new commercial infrastructure will increasingly be required in remote areas in western and northern Australia. However, established resource centres on the east coast, such as the Hunter Valley and the Surat Basin will continue as a backbone of Australia's resources sector for the foreseeable future.

In anticipation of the return to growth, the Minerals Council of Australia released its Vision 2020 Project earlier this year, which proposed the infrastructure requirements to fill gaps it identified in Australia's key minerals resource regions. To achieve its aim to recapture lost market share and accelerate growth, the report found that the common need across all resource regions is for upgraded and increased capacity and connectivity with the wider national infrastructure network.

Some ports (such as Geraldton and even Darwin) suffer from constraints on handling larger bulk carrier ships, while further expansion of freight rail into ports such as Townsville, Brisbane, Newcastle, Port Kembla and Geelong will need to provide balance in managing the impacts on urban congestion.

Competition for 'third party' access to rail corridors can also be an issue for growth amongst neighbouring operations.

Any plans for supply chain expansion, particularly in remote areas, must be accompanied by adequate supporting industrial and domestic infrastructure such as water, energy, housing, aviation and community facilities. Planning for workforce growth, including how to acquire acute skills or respond to labour shortages, in part a result of an ageing workforce, is an essential consideration across the resource sector.

To meet these future challenges, investment in our ports and rail supply chains will need to leverage both public and private investment across the infrastructure lifecycle. It is a difficult environment in which this need arises, as noted by Infrastructure Partnerships Australia in a discussion paper released earlier this year: "There is now a significant limitation on the amount of debt which can be raised in the Australian market for infrastructure invest-

ment. There are fewer banks active and prepared to lend – and those which are active in the market are only prepared to lend significantly smaller amounts."

The Australian Government has thus embarked on a national investment pipeline as part of its Nation Building agenda. In 2008 the Commonwealth Government established the Building Australia Fund (BAF) to publicly finance major infrastructure project. Allocations from the BAF were guided by the priorities and recommendations of Infrastructure Australia, which undertook a national infrastructure audit and established an investment priority list.

Best-practice, nationally consistent Public-Private Partnership (PPP) Guidelines for private sector investment were also endorsed last year by the Council of Australian Governments (COAG).

Specific BAF investments include \$339 million towards common use infrastructure for a new deepwater port at Oakajee in WA, to enable the loading of Cape-sized vessels and relieve ore-loading congestion at Port Geraldton.

The Federal Government has also committed \$50 million towards Darwin Port to accommodate large ships suited to the transportation of bulk resources and commodities, subject to further work and consideration of the project by Infrastructure Australia.

Going forward, the Government will seek to leverage such investments to secure private sector equity.

The BAF investment sits alongside the Australian Government's \$26 billion five-year National Building investment program.

A considerable portion of this funding is committed to upgrading and extending our national and regional road networks, in order to improve safety and conditions, and

To meet these future challenges, investment in our ports and rail supply chains will need to leverage both public and private investment across the infrastructure lifecycle.

NICTA BREAKTHROUGH PROMISES SAFETY-CRITICAL SOFTWARE

NICTA has announced the completion of the world's first formal machine-checked proof of a general-purpose operating system kernel – which it claims is a milestone that paves the way for a new generation of software capable of unprecedented levels of reliability. It means there is now a way to mathematically prove that the software governing critical safety and security systems in aircraft and motor vehicles is free of a large class of errors, long before the plane takes off or the car's engine starts, NICTA says.

The Secure Embedded L4 (seL4) microkernel, designed for real-world use, has

potential applications in defence and other safety and security industries where the flawless operation of complex embedded systems is of critical importance.

"Formal proofs for specific properties have been conducted for smaller kernels, but what we have done is a general, functional correctness proof which has never before been achieved for real-world, high-performance software of this complexity or size," explained NICTA.

The proof also shows that many kinds of common attacks will not work on the seL4 kernel. For instance, the microkernel is

impervious to buffer overflows, a common form of software attack where hackers take control of programs by injecting malicious code.

To reach this milestone, the NICTA team invented new techniques in formal machine-checked proofs, made advances in the mathematical understanding of real-world programming languages and developed new methodologies for rapid prototyping of operating system kernels.

"NICTA's completion of original ICT research of this calibre is a triumph," said NICTA CEO Dr David Skellern FTSE.

reduce congestion and journey times for all road users including freight transporters.

For example, the Network 1 project along Australia's busiest freight route will mean 85 per cent dual carriage-way from Melbourne to Cairns by 2014. Victoria's highly anticipated M80 Ring Road upgrade is a \$2.25 billion project to widen and improve the Western and Metropolitan Ring Roads.

South Australia's Northern Expressway will be a new 23 kilometre road and is the largest road construction project in the state since the 1960s. To the north, the three-stage upgrade of the Ipswich Motorway in Queensland's Western Corridor will benefit one of the state's key growth areas, in the south-east region.

Significant rail investment will also boost the Hunter Valley coal chain, which is the world's largest coal export supply system. The Government-owned Australian Rail Track Corporation is investing more than \$1 billion to improve coal carrying capacity in the region. In addition, \$1.2 billion is being invested in Hunter Valley rail expansion and to upgrade other key sections of the national rail network, plus \$2 billion committed to rail infrastructure from the Nation Building Program for a range of national rail projects, including at Port Botany, Geelong Port and Bell Bay in Tasmania.

These programs have multiple benefits for the community – construction activity supports local industry and contributes to jobs creation in the short term, while the establishment of durable and appropriate infrastructure benefits communities and the economy in the long term.

Effective coordination between Federal, state or territory and local governments is also critical, given the shared interests and responsibilities and the need to deliver projects without unnecessary delay and according to scope.

Australian governments have together identified the need for a consistent national approach to transport regulation to ensure that the overall system operates efficiently and safely to underpin maximum productivity. COAG has agreed landmark decisions to set up single national regulatory systems for heavy vehicle regulation, maritime safety, and rail safety regulation and investigation.

While many issues of principle and of detail remain to be worked out, current anticipation is that the new national laws and institutions would come into being in 2012, with a view to full implementation by 2013. This will result in historic outcomes – single national regulation for

all our heavy vehicles, rail and shipping systems, overcoming the multiplicity of different state systems which have added to cost and complexity for business.

While improving our national and regional road networks will continue, the infrastructure needed for a productive 21st century Australia will necessitate a keen focus on ports and rail for delivering our resources to markets. Getting this right requires multi-layered partnerships between the public and the private sectors as well as innovative and robust intergovernmental coordination.

Removing impediments to progress and guarding against future bottlenecks in a future resources growth cycle will need to drive development of a national infrastructure pipeline, institutional and regulatory reforms, skills and financing strategies across the lifecycle, the facilitation and stimulation of private sector involvement as well as the integration of supply chain and congestion management policies for major cities.

For those tasked with developing and implementing such significant and far-reaching programs, it is anything but business as usual. ◀

MIKE MRDAK has been the Secretary of the Department of Infrastructure, Transport, Regional Development and Local Government since June 2009. Before that he was Deputy Secretary (Governance) in the Department of Prime Minister and Cabinet and served as Commonwealth Coordinator-General, working with state and territory coordinators-general to ensure implementation of key Commonwealth stimulus measures. He first joined the infrastructure portfolio in 1988 and has had responsibility for managing transport and portfolio policy issues including international and domestic aviation policy and regulation, infrastructure investment, the COAG competition policy reform agenda, rail investment and regulatory reform, maritime policy and the portfolio's interests in emissions, energy and natural resources policy.

MIKE TAYLOR AO FTSE has been Chair of the Murray-Darling Basin Authority since May 2009. He is an experienced, senior public administrator, serving as Secretary of the Commonwealth Department of Infrastructure, Transport, Regional Development, and Local Government (2004–09), Secretary of the Department of Agriculture, Fisheries and Forestry (2000–04), Secretary of the Victorian Department of Natural Resources and Environment, (1996–00), Secretary of the Victorian Department of Agriculture, Energy & Minerals (1995–96) and Secretary of the Victorian Department of Agriculture (1992–95).

Contributions are welcome

Opinion pieces on topics of national interest will be considered for publication in *ATSE Focus*. Items between 800 and 1500 words are preferred. They must list full name, title/role, organisation (if relevant), city of residence and email address for publication. Please address to editor@atse.org.au

Achieving the best options for electricity distribution

A further challenge is the current climate-change induced public enthusiasm to connect new wind and solar farms, and to develop decentralised (or distributed) generation



By Martin Thomas

mhthomas@bigpond.net.au

Electricity distribution is the essential link between electricity generation and its customers. Taken for granted and often reviled for its visual intrusion in our streets and our countryside, it is nevertheless the *sine qua non* for all but those who rely on candles, oil lamps or dung for home light and heat. Although a life and industry staple, electricity distribution offers very many options.

History

The earliest municipal electricity generators in about 1880 produced direct current (DC) at around 100 volts to supply the principal electrical load of the time, the vacuum incandescent lamp, made practical by Thomas Alva Edison.

While 100V was attractive for household lighting and DC motors, needing little insulation, it was limited to short transmission distances. Losses were high and copper usage considerable. Early DC plants generally lay within 2.5 kilometres of their loads and interconnection as we know it today was beyond the reach of DC technology.

The advent of alternating current (AC) by the brilliant Serbian engineer Nikola Tesla and development of the transformer, using Michael Faraday's principles of electro-

magnetic induction, made economic the transmission of electricity at higher voltages, using less copper and enabling far greater distances between generator and consumer.

However, the resulting 'war of currents' (like the later Beta versus VHS war – for those of you who remember the early days of video) was not resolved in favour of AC until the early 1900s, with Edison holding to DC (to protect his investments!) and others, including Charles Merz, developing AC at ever higher voltages. (Charles Merz was the founder, in 1899, of my old firm Merz and McLellan, later Sinclair Knight Merz or SKM).

But it was the development of the large and reliable reaction steam turbine in the 1890s by Charles Parsons, a great friend and technical compatriot of Merz, which enabled the high voltage AC 'grid' as we know it today to bring cheap electricity, using abundant north-east England's coal, to widespread UK load centres. Merz was indeed a pioneer, being engaged by governments worldwide to give advice on public high-voltage transmission systems – including for Victoria, as it expanded its electric railway system in the early 1900s.

Today, 500,000V transmission and higher is commonplace in industrialised countries and an extraordinary 1,150,000V is used on a system in Kazakhstan.

Distributing electric power

Initial DC distribution required only two wires, one safely at earth potential. Improved DC system use was achieved with three wires – positive, negative and an earth return. However, transformers permitting much higher AC transmission voltages created issues of standard voltage levels, frequency (Hz) and the use of three phases of delta or wye connection and steel-cored aluminium conductors for strength and conductivity.

Industry standards, used by today's utilities, are outside the scope of this article, beyond noting the European usage of 50Hz and the US's adoption of 60Hz. The bemused Japanese use both, with complex voltage changing interconnections. But we need to remember that not long ago mining outposts like Broken Hill had 25Hz AC as well as 600V DC systems. Enigmas are not limited to rail-track gauges!



Equipment and technologies

Early electricity distribution used much the same ubiquitous timber poles as seen in our streets today; although growing scarcity and the attractions of better fire resistance, lower maintenance and longer lives are leading to synthetic alternatives such as lightweight glass fibre reinforced concrete. Nevertheless poles, whether for DC or AC, are limited in the voltages they can handle and thus the power they can safely carry.

As transmission voltages rose to the thousands, then tens and then hundreds of thousands of volts, the sometimes elegant, sometimes appalling, lattice galvanised steel towers emerged as the international standard. Tower heights and spans grew, with 340 metres and over 5000m respectively being recorded. Conductors (wires) multiplied, with up to six in a bundle, held firmly apart by spacer dampers, for the highest powers and voltages. Indeed dampers are near essential to avoid potentially destructive induced Aeolian vibrations in long conductors – sometimes heard humming like violin strings.

Power is also carried underground (and under the sea) using specially insulated and strengthened cables, albeit at far greater expense due to the cables themselves, their rights of way, access tunnels and the like. Optical fibre software driven distributed temperature sensing (DTS) systems will become the norm. Thus, although thought unsightly by most, air-insulated overhead transmission and distribution is likely to remain the more common option.

High voltage DC (HVDC) is used for efficient economic transmission of large loads over long distances with no intervening loads. While the DC carrier technology is simple, the AC/DC conversion station technology at each end is not. Historically such conversion called for large rotating converters but today advanced static inverter devices are used instead. The highest capacity HVDC system in the world, just over 6000MW, is used to transmit the output of a very large Brazilian hydro power station to the load centre.

For small distant loads, for example outback properties with little more than a freezer, some lights and a shearing shed, the cheap and effective technology of choice is single wire earth return (SWER), developed first in New Zealand but in common use in Australia. Typically 12.7kV, SWER feeders employ long taut spans with a step down transformer at the load.

Regardless of the system configuration, voltage or frequency, electricity is dangerous, killing people readily and having the potential to unleash massive energy flows. Moreover it needs to be switched – simple at the domestic 240V single phase level, quite another matter at 765,000V three phase. Thus a comprehensive family of switching and protection products have evolved from the humble domestic re-



wireable fuse (mercifully on the wane) to the hugely sophisticated very high fault current rated HV circuit breakers.

Planning the network

Most power distribution, unless to remote loads, is via an interconnected network with many voltage levels and sometimes HVDC interconnectors, as between Queensland and NSW. This is ideal for supplies to towns and industries where multiple supply sources offer significantly improved reliability and security. Radial feeders are more suited to remote loads. Broken Hill, for example, is served by a single overhead 220V transmission circuit.

The eastern states of Australia, from northern Queensland to South Australia and Tasmania, are all interconnected. Nevertheless, as so succinctly pointed out by Dr John Sligar in a recent ATSE Workshop, interconnections are far from strong. Load flows are limited, especially between states.

A further challenge is the current climate-change induced public enthusiasm to connect new wind and solar farms, and to develop decentralised (or distributed) generation using as well a whole range of localised new sources, such as coal seam methane, geothermal sources, fuel cells, small co-generation units and even waves and tides. These typically 'off

Installing
Dulhunty
Power spacer
dampers on
765,000 volt
transmission
lines in the
US.

grid' sources will not only call for significant grid extensions but also new and very advanced system control features. Such evolution will need substantial new planning and investment – an issue that Dr Sligar attests is still off the table.

Looking to the future

What does the future hold for electricity distribution infrastructure? Perhaps the most exciting technical development is that of superconductors. At near absolute zero temperature some conducting materials exhibit near zero resistance. While such low temperatures are impractical for other than highly specialised applications, more recent discoveries of materials exhibiting so called 'high temperature superconductivity' at temperatures above that of the boiling point of cheaply produced liquid nitrogen hold out commercial application promise.

In network evolution the so called 'smart grid' promises change. Brought about through growing distributed generation opportunities, as well as the self-managed intervention of intelligent, well-informed, price-conscious customers and their agents, distribution grids of the future will employ smart metering and an ever-growing array of programmable measurement and control devices.

Plug-in electric vehicles (PHEVs) offer vast discretionary

system storage and load levelling potential and will markedly impact future urban system development and management. The challenge will be to develop international standards and protocols to avoid 'rail gauge' issues from the outset – but the 'trains of numerous gauges' already have a considerable head of steam and standardisation will be far from easy!

Australian electricity distribution infrastructure, like its road, railway and water systems, appears to have settled down to internationally accepted and standardised practices. The changes ahead will lie more in the way we use the system, what new generation resources it will employ and, of course, who will own it! ◀

Concluding as a principal of Sinclair Knight Merz, MARTIN

THOMAS AM FTSE had an extensive career in energy consulting and then became founding MD of the CRC for Renewable Energy (ACRE). Other roles have included Deputy Chairman of Australian Inland Energy, directorships of Tyree Group and Enviromission, chairmanships of Austenergy, NSW Electricity Council and Sydney 2000 Olympic Energy Panel. He is Chairman of Dulhunty Power, adviser to ZBB Energy and was a member of the Uranium Mining, Processing and Nuclear Energy Task Force. He is a past president of the Institution of Engineers, Australia, and of the Australian Institute of Energy, and a past Vice-President of ATSE.

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CONTENT MATTERS

Building an efficient national roads system

We tend to forget how permanent roads are and how ongoing are the benefits and disbenefits that they create



By Max Lay

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Roads are an integral part of our nation's infrastructure. British colonisation in 1788 brought with it the requirement that every piece of subdivided land had to have land access via a public right-of-way. The land was often grudgingly given and was rarely part of any grander transport plan. Thus, almost from the beginning, governments have had to step in and impose a grander vision beyond the farm-to-market needs of individual land owners.

For example, Melbourne was created in 1836. The first land sales were in 1837 and by early 1841 the man in charge, Superintendent Charles La Trobe, was rebuked by the Colonial Secretary in Sydney for not providing adequate land access to properties and for not having appropriate forward planning.

La Trobe responded later in the year by producing a plan with 15 arterial roads leading out of the small new settlement. In one form or another, all exist today. We tend to forget how permanent roads are and how ongoing are the benefits and disbenefits that they create.

The problems La Trobe faced are the same as the problems we face today. What are the reasonable transport demands of all the various land users? What is the best way to satisfy those demands? How will those demands change with time?

If the last query sounds a little esoteric, remember that roads are usually the longest lasting and oldest piece of infrastructure in our communities. One of the Melbourne routes being studied today as a result of the Eddington review is a route that first appeared on La Trobe's 1841 plan.

Forward planning is not easy. An apocryphal state planning official remarked: "If I could predict the future, I'd be on a beach in the south of France and not working as a Grade 2 government planning officer." A key element of forward planning is the estimation of future population. Various retrospective assessments indicate that 25 per cent errors are commonplace and recent experiences with toll-road traffic confirm these levels.

Another major problem has been our inability to control, let alone predict, future land use. State governments need to be much better in the way in which they match land-use controls with economic and social strat-

egies at one extreme and transport plans at the other.

Thus, road planning must allow for a range of future scenarios, as today's assumptions and passionately held views are quite likely to be proved wrong. To avoid past parochialism, planning for any new road system must also be done at a level above the immediate region affected by the planning.

Australia is not alone in tackling transport issues. Much can be gained from comparisons with other transport systems in other countries, some of which will already be experiencing our future and even doing some things better than we are.

In the area of land transport, my own observation of world trends is that the best systems have good road networks and good fixed-track systems. It is not an either/or decision. Major centres are linked by freeway-standard roads and all significant towns have road bypasses or ring roads. However, the bulk of surface freight and much personal transport between centres is carried by rail.

It seems to me that these should be 'givens' and the debate should be focused on how to deliver this core system and on which areas should be designated 'major centres'. This designation must be coupled with other national policies and with the strongest of land-use controls.

After his recent review of Australian infrastructure, Sir Rod Eddington remarked that he was surprised by the lack of 'shovel ready' projects. I had come to the same conclusion in a review I did of Australian infrastructure investment for an international agency.

In the rational development of infrastructure there is a pipeline of potential future projects, ranging from good ideas at one extreme to contracts about to be let at the other.

Ideally, the initial pipeline stages are as follows.

1 Tapping the three generators of future transport needs:

- needs for efficiently and effectively operating the existing road system;
- future needs from demand-producers such as land-use and population changes and economic trends; and
- needs generated by government policies, political decisions and innovative proposals.

2 Using these needs and expected budgets to produce a transport strategy, and then a set of specific proposals to address the needs.

3 Removing projects which are unsustainable or environmentally unacceptable.

4 Selecting the proposals with benefits exceeding costs.

5 Selecting the most appropriate remaining projects, gaining approvals to proceed and preparing project documentation for bidding.

This last is the 'shovel ready' stage.

There is no need for any secrecy in stages 1 to 4. However, in recent decades state governments have frequently

acted more like magicians than forward planners.

They have drawn back curtains at the last possible moment to announce their next major project. Magically, untested and under-developed concepts become projects about to be built. Behind the curtains, there has been no consistent canvassing of needs, no structured forward planning and only the most secret and subjective of project assessments.

So when someone like Eddington asks "why do you advocate project X?" the answers are patently unconvincing. Furthermore, the project deliverers have had no chance to prepare in advance for the next round of projects.

We must ensure that good judgement is not overwhelmed by the intricacies or un-needed secrecies of plan-

AUSTRALIAN SPATIAL INDUSTRY WINS FUNDING

Key Australian industries will gain access to new data, technologies and services through the \$40 million funding of a major research program in satellite positioning and remote sensing technologies, announced in the recent CRC funding round.

With a total budget of \$180 million, the new Cooperative Research Centre for Spatial Information (CRCSI-2) involves more than 100 organisations, including government, the private sector and universities, in an eight-year joint venture.

"The new CRCSI will help us to remain internationally competitive and capitalise on rapid growth in the spatial industry. The CRC Program's investment in this industry will deliver tremendous benefits to the nation," said Professor Mary O'Kane FTSE, Chair-elect of the CRCSI-2 Board.

CRCSI says the spatial information industry

currently contributes an estimated \$12.6 billion to national GDP and direct outcomes from CRCSI-2 are expected to deliver a further \$305 million to the nation if emerging developments can be leveraged for Australian industry. The wider benefits are far larger.

More than 90 end-users, mostly small and medium companies, will participate in the program to direct and speed delivery of research outcomes to several industry sectors including:

- health – preventative medicine policies will be improved through the way in which spatial information can show patterns of disease which are otherwise undetectable. CRCSI-2 will spatially analyse data for early detection of colorectal cancer and childhood leukaemia;
- energy and utilities – unmanned aircraft will monitor powerlines with laser scanners to get timely, accurate knowledge of the condition

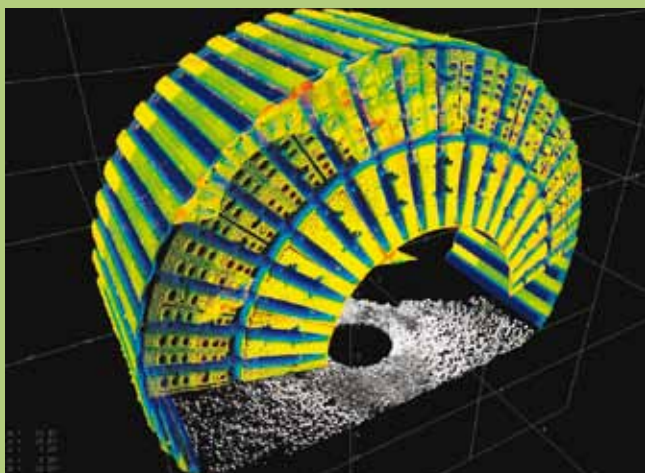
of power infrastructure, which will improve safety and reduce costs for consumers;

- sustainable urban development – planning, transport costs and 'living affordability' in our cities and towns will be assisted by spatially understanding what makes good urban areas work;
- agriculture and climate change – farmers will have more precise information to guide the planting, treatment and harvesting of crops due to spatial precision agriculture. Scientists and land managers will be able to monitor landscape changes more closely, which is particularly important given the widespread effects anticipated from climate change;
- defence – research into new imaging technologies for national defence.

Through its strong international linkages, CRCSI-2 will also be targeting overseas markets to deliver new technologies and services.

IMAGE: SCANALYSE PTY LTD

Laser scan of a crushing mill revealing wear in the lining plates.



Spatial information is at the core of a number of platform technologies and services, from traditional surveying to contemporary technologies such as GPS and location-based services. It describes the location of objects in the real world and the relationships between objects. Practical applications include environmental monitoring, GPS services, customer relationship management and the management of natural resources, biosecurity, assets, land and emergencies.

ning and assessment. In addition, uncertainty about the future need not be an impediment.

For example, in planning for conditions in 2030, the first test is to consider the rate of change from 1990 to 2010. Could the proposed forward plan manage the quantum of changes that have occurred over the previous 20 years? History has amply illustrated that one of the great transport advantages of the road system is its ready adaptability to change.

The indications from the 2008 ATSE Report by Professor Len Stevens (*Assessment of Impacts of Climate Change of Australia's Physical Infrastructure* – www.atse.org.au/index.php?sectionid=1287) are that the road system will be relatively immune to the effects of climate change.

almost-complete absence of intelligent transport systems managing traffic on the road system.

Despite the available technology, vehicles today operate as independently of each other and are as subject to the same irrational whims of their drivers as they were a century ago. Thus there is much that can be done to enhance the existing road system for both freight and personal transport via information technology, systems management and improved vehicle technology.

Hopefully the lessons of history and geography have been learnt. All nations need an efficient road system. The evidence of many countries and times is that it can only be achieved with persistence and good and appropriate planning. ◀

Melbourne's EastLink project won the 2009 Australian Construction Achievement Award, presented by the Australian Constructors Association and Engineers Australia. The \$2.5 billion EastLink is a 45 kilometre road that connects Melbourne's eastern and south-eastern suburbs. Completed in 2008, five months ahead of schedule, it was Australia's largest road infrastructure project at the time of construction.



A point which is rarely understood is that in the total operation of a road system, the cost of building and maintaining the road in annualised terms is commonly only about 10 per cent of the costs being incurred by those using the roads. This explains the relatively high benefit/cost ratios associated with many road-construction projects.

Optimising the system must therefore focus primarily on optimising the usage of the system and not on its construction. A rational system of user charging is part of this process, but a larger part is the use of more efficient and appropriate vehicles and fuels.

Examples that readily come to mind are large passenger vehicles inefficiently carrying single passengers, truck designs that fall well short of world's best practice and the

FURTHER READING

M. G. Lay, 2009. Review of the 2008 Victorian Transport Plan (with an emphasis on the road aspects) (*Victorian Planning News*, 35(1):18-19, February)

DR MAX LAY AM FTSE PhD DEng HonFIEAust was made a Member of the Order of Australia in June 2005 for "service to engineering, particularly through leadership in the delivery of quality road infrastructure and the development of new contract management processes, and as an educator and historian." In July 2009 he was awarded the John Shaw gold medal by Roads Australia. He is the author of articles on roads in the *Encyclopaedia Britannica* and the *Oxford Encyclopaedia of Economic History*.

Dr Max Lay's book *Handbook of Road Technology* has gone into its fourth edition. The 944-page hardback book – in the words of the publisher – continues to be an indispensable international resource for students and professionals in transport planning, engineering, operations and economics. See ATSE in Focus (page 40).

Total architecture and the 21st century city

The most sustainable model for human habitation, in every sense, is the city. But how can we achieve the sustainable city from where we are now?



By Robert Care

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Consider the following as a view of the city of the future:

The city is established initially with north-south and east-west axial streets, and is laid out as a grid. Each block is envisaged as a programmable slot and is mixed-use, containing apartments, houses, shops and workshops, creating a dense city core. Urban amenities such as plumbing, reservoirs, drainage and sewers, pedestrian sidewalks and traffic calming measures are employed throughout, along with public amenities like markets, public baths and toilets, theatres, and religious and governmental buildings. Between the urbanised zone and the city boundaries is a buffer zone, and beyond lies agricultural land.

The city's population is actively engaged in public life, through sport, food and drink, and an outdoors '24/7' culture, but also through political discussion. Active transport ensures a strong, healthy populace, almost all waste is recycled, and food production is localised and distributed throughout, with orchards, vines and herb gardens integrated into living spaces. Light industry is also distributed throughout the city, and connected globally through trade networks. Global communications are at the centre of the city's success.

Housing is based upon the courtyard house model, with an average of 3.5 people living in a dwelling featuring two private courtyards, one of which collects rainwater that feeds subterranean water tanks. Cooling is achieved through passive design, and heating through the inherent thermal properties of ceramics.

Although dense, 69 per cent of land use is green space, leaving 11 per cent for infrastructure and 20 per cent for built area. Of that built area, 52 per cent is public space and 48 per cent is housing. Of the green space, only two per cent is devoted to parks, as the other 98 per cent is a productive landscape of urban agriculture, far more ubiquitous than the hemmed-in green spaces of the 20th century city. As citizens spend much of their time in this verdant space, dedicated parks feel less necessary.

The entire urban form is modular, flexible and capable of being repeated in numerous contexts and locales. It has been tried and tested throughout much of the known world, and refined through adaptation with each iteration.

Perhaps the reference to public baths gives it away, but this is actually a description of the archetypal Roman city circa 500 BCE to 500 CE (drawn from the recent exhibition and book *49 Cities* by New York architecture company Work AC).

Of course, the Roman city had more than a few flaws and not just for the slaves – even the healthiest citizens had life expectancies far lower than we would accept today. Furthermore, there are new technologies that the 21st century city should certainly take advantage of, such as renewable energy production, wireless connectivity, bicycles and, of course, the espresso machine.

Yet it's surprising how similar the visions of contemporary urban planners – with their own versions of urban agriculture, active transport, walkable densification, courtyard housing with passive design, recycling, localised production and so on – are to this Roman city from two millennia ago.

Clearly, looking back at urban history can be useful, but we must not simply cherry-pick from the past. After all, we are facing challenges that have no precedent in human history. Given the urgent need to mitigate the impact of climate change, we must find a more sustainable mode of being. Yet the inability to manoeuvre the built form into another shape makes this impossible, doesn't it?

Not necessarily. Cities are both the problem – the source of most carbon emissions – and the solution. The most sustainable model for human habitation, in every sense, is the city. But how can we achieve the sustainable city from where we are now?

We can approach the built fabric we already have, retrofitting existing buildings and neighbourhoods with more sustainable infrastructure. We can manage most of the population growth that cities require well within their existing boundaries, through careful and sensitive densification – at the scale of Barcelona or Paris's four-storey courtyard blocks, rather than high-rise, for example – or, indeed, the Beijing courtyard-house-and-hutong model.

Traffic could be reduced through congestion charging or pay-for-use, which could then fund more sustainable



Greenhouse by Joost: a temporary incursion into Federation Square, Melbourne, last summer – a fully recycled structure made from straw bales and recycled materials, covered with a green roof and walls growing food used in the bar/café within.

transport modes, such as smart shared bikes or light and high-speed rail – just waiting to be installed over our existing asphalt arteries. Australia in particular is blessed with so much ‘naturally occurring’ energy (solar, geothermal, wind, tidal) it could probably power all of Asia, if it wanted to.

Streets can be greened almost effortlessly, enabling better rainwater handling, natural cooling and, most importantly, sheer delight. Distributed production alongside locally owned stores supported by smart home-delivery networks can replace ‘big box retail’, and so on.

Many of the technical solutions are already available, and could be implemented at little overall cost. Yet we still cannot move quickly enough. The problem of changing hard infrastructure is not necessarily technical, but social, cultural, legal and political.

To effect these changes would entail nothing less than conjuring up ‘a new Australian dream’: a richer version than simply owning one’s own quarter-acre block.

As a nimble and cosmopolitan New World nation, one of the most urbanised in the world, we are well placed to do this – to find a way of preserving individual creativity and ambition within a deeper understanding of interdependent sustainable cities and regions, to balance the individual with the community, and the systems that sup-

port both. This means fully taking on what Peter Head describes as ‘the ecological age’, and understanding that cities are indeed systems – albeit containing humans and, therefore, the most complex systems of all.

This ecological age vision fundamentally reinvents approaches to urban development, no longer based around the equivalents of GDP as the only measure of human development but, rather, taking into account environmental, social and humanitarian as well as economic factors. Here, again, we can draw from history to understand the non-built aspects of our world.

We might look at the urban development process itself from an economic, legal and social perspective. Cities are essentially ongoing, organic processes, with the best bits often the function of what Jane Jacobs (the urbanist, writer and activist best known for her book *The Death and Life of Great American Cities* (1961), a critique of the US’s urban renewal policies of the 1950s) would have recognised as emergent processes. Given this, the structures of development processes and planning tend to work against the grain, in fits and starts, based on periodic snapshots such as census data rather than real-time feedback.

This model does not allow for iteration, unlike the design processes for, say, cars, mobile phones or websites. If

we can find a way to iterate development, using the kind of small 'urban acupuncture' with which Jaime Lerner has so successfully transformed Curitiba, or the various retrofitting strategies we are devising at Arup, we can enable the citizen to engage with the city once again.

It may no longer be a tangle of 1950s-era highways, high-rises and CBD streets strewn with tumbleweed after 6pm, but something that everyone feels part of and understands their part within. Responsibility might feel engaging, rather than a hassle.

We might use smart technology, such as sensors, liberally sprinkled over the urban environment, to perceive and understand this living system in more detail, feeding back in real time the way the city is actually being used. Careful design could ensure that privacy is preserved, recognising that city life at its best perfectly balances anonymity and community.

Yet this urban informatics could allow the city to be understood as a real-time system for the first time, enabling a supremely efficient allocation of scarce resources. It could allow the realisation of a newly responsive urban landscape, sensitive to the touch and alive with visualisations both meaningful and delightful. The post-industrial city could have the kind of everyday feedback loops that the Roman city benefited from.

Equally, we must ensure that design and development is holistic. Ove Arup talked of 'total architecture', implying that only in the convergence of disciplines will we find the most creative yet pragmatic solutions. Only by balancing qualitative inputs ('What makes a great street?') alongside the quantitative ('And who will pay for it?') will we find a way towards a balanced sustainable city.

In the past, too many cities have been blighted by a simplistic preoccupation with bottom lines, and there is an obvious if awful parallel here – Sir Nicholas Stern calls climate change the biggest example of market failure in history.

A greater understanding of people in particular – all the messy stuff that planners and designers have traditionally shied away from, such as cultures, ambitions, desires, fears – will deeply inform this new development process. Total architecture encompasses the 'quality and the quantity', the top-down systems and emergent patterns, the people and the objects, giving us a holistic way of balancing good business and good design, leading to great cities.

So alongside our technical and creative expertise, we are interested in enhancing our understanding of cities in a holistic sense, and then creating visions that people actually begin to desire.

We are not talking about the Roman city as a literal model. Nor do we see a sustainable city as a necessarily humble, bleak vision, in which your hemp toilet paper endlessly circles around your continually blocked greywater toilet, or as a gleaming oasis in the desert outside Abu Dhabi, but instead Sydney, Melbourne, Brisbane, Perth and others – retrofitted, reoriented and renewed. ◀

DR ROBERT CARE FTSE is CEO and Chair of Arup Australasia. He is an Adjunct Professor of the School of Civil and Environmental Engineering at the UNSW, a Fellow of Engineers Australia and an Associate Fellow of the Australian Institute of Management. His commitment to the community is reflected in his appointment in 2006 as a director of RedR Australia (Registered Experts for Disaster Relief) and his appointment as Chair of RedR Australia in November 2008.

"HARDENING AUSTRALIA" NEEDED FOR NATURAL DISASTER RESILIENCE

Australia needs to encourage climate-hardening of critical infrastructure, according to a new report by the Australian Social Policy Institute, *Hardening Australia: Climate change and national disaster resilience*.

The report calls for a new body, the Australian Land Use Planning Taskforce, to be established to develop a national approach to driving climate-change adaptation considerations into land-use strategies and decisions.

The report finds that buildings continue to be produced that will not resist hazards predicted over coming decades, making reforming the Building Code of Australia – to increase building durability and resilience – more urgent.

Report authors Athol Yates and Anthony Bergin warn that as a result of climate change, disasters are likely to become larger, more complex, occur simultaneously and in regions that have either not experienced the natural hazard previously or at the same intensity or frequency.

The report recommends that emergency services undertake a comprehensive assessment of the impact of climate change on the risks they are responsible for.

It calls for COAG to develop a National Partnership Agreement on Disaster Resilience with the states that would provide \$150 million to reward the states' measurable

improvement in disaster outcomes.

It also says climate change should be acknowledged by Australian security planners as a major security threat and that climate change should be used to embed disaster risk reduction into the work of relevant government agencies and critical infrastructure owners and operators.

The last of its 11 recommendations is that governments should review new and emerging social networking technologies to respond to disasters better.

The report can be downloaded at www.aspi.org.au

Abandoning Babylonian principles to rebuild our irrigation infrastructure

Australia reflects the world water situation well. Australia's water is already recognised as an activity-limiting resource that is further challenged by population growth and climate change



By Iven Mareels

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In the early 1880s when Alfred Deakin argued the case for irrigation in Australia, he observed that irrigation was as old as human records – it is inseparably linked to the dawn of civilisation.

Natural flood irrigation in the Nile Delta sustained ancient Egypt and the extensive irrigation infrastructure in Mesopotamia underpinned the greatness of the Sumerian and Babylonian empires, as epitomised by the hanging gardens of Babylon.

Throughout time, the case for irrigation has always been made on the grounds of productivity and economic gains in agriculture. Deakin observed anecdotally a 10-fold productivity gain of irrigated land over dryland farming, but factors between three and five are more commonly reported. He also observed that water was not in short supply, but that Australia had a water-management problem that could be addressed through an irrigation system.

Essentially, any irrigation infrastructure redistributes, both temporally and spatially, hydro-cycle water so as to protect the crops against the vagaries of natural rainfall. As our understanding of hydraulics has matured this infrastructure has evolved, nevertheless the basic ingredients were already well mastered by the Sumerians.

At some altitude, run-off water is harvested and stored in dams. When water is required it is released from the dams. Under the influence of gravity it runs through a system of channels equipped with flow-regulating structures to irrigate the cultivated land. After its agricultural use most of the water re-enters the natural hydro-cycle, with typically less than one per cent of supplied water stored in plants and animals.

As the plain of Mesopotamia was an arid region, the Sumerians had to administer water allocations and managed their infrastructure carefully so as to achieve water allocation fairness. An extensive set of regulations and experience-based practices implemented by a dedicated temple-dependent labour force, overseen by a special cast of priests, saw to that.

Unfortunately they did not grasp the need for adequate

A BILLION PEOPLE WITHOUT ADEQUATE WATER

On the world scene, population growth and climate change will cause the greatest pressures on water usage, but almost equally important are the world's social equity responsibilities.

The world has set itself the very reasonable goal to eliminate hunger by 2020. This requires more water to feed a billion people who now experience hunger on an ongoing basis. Furthermore, a more affluent world population uses more water for industrial and domestic purposes and – even more demanding from a water point of view – prefers an animal-protein-rich diet.

Equity demands that we improve water access for the billion world citizens with access to less than 50 litres of clean water a day.

All three World Water Reports, and IBM's recent Global Innovation Outlook report on water, candidly speak of a water management crisis, and discuss at length the absence of water efficiency and the paucity of reliable data. Across all consumptive use – urban, industrial and agricultural – water efficiency (the amount of water purposefully used over the amount of water extracted from the environment) is estimated at less than 50 per cent. The WWF (formerly the World Wildlife Fund) estimates irrigation efficiency at less than 40 per cent. The majority of water extractions – some 70 per cent – support irrigation.

drainage and, as a consequence of the oversupply of irrigation water, they eventually poisoned the soils as mobilised salts rose to the surface.

The world's present water management is equally considered unsustainable because of the observed ecological deterioration of most of our natural water systems, but actually estimating the water resource that is readily and sustainably available for human activity is difficult. It is severely hampered by the paucity of quality data. Groundwater data in particular are scantily available.

Australia reflects the world water situation well. Australia's water is already recognised as an activity-limiting resource that is further challenged by population growth and climate change: most of our urban communities are used to water restrictions; our farmers are subject to vastly reduced irrigation allocations; and our main river system –

the Murray–Darling – suffers severe environmental stress.

In spite of this, our water infrastructure (like the rest of the world) is still largely fixated in the Deakin era, and our operational practices are definitely Sumerian/Babylonian in nature (although admittedly no longer temple-based) and suffer from low efficiency. This does not augur well for the future.

It is essential to modernise the water infrastructure so as to improve water efficiency and in general achieve a more sustainable socioeconomic and environmental water-management outcome within the ill-understood constraint of the available water resource. Irrigation is not a bad place to start.

Some progress can be made by investing in more civil infrastructure – better leak control, precision irrigation, water recycling, desalination and so on. However, these are inherently very expensive options and many come with a heavy and presently totally unwelcome energy penalty. Although it is clear that some of these investments are necessary and will lead to better water efficiency and water availability, the relative trade-offs are not well understood because of a lack of data.

Ours is a water-management problem, so greater gains can be achieved by improving the water decision-making processes through better information at all levels of decision making. More uncertainty (climate change) and tight constraints (demand pressure) combine to create a very challenging decision-making environment overall.

Australia, and the world, is poorly equipped to deal with this because our water infrastructure (both the natural as well as the engineered water infrastructure) is information-poor. The available data lack both the spatial and the temporal resolution necessary to support appropriate decision making. Neither the water user, nor the policy maker, nor the water infrastructure manager obtains sufficient data. Presently available water consumption data are uninformative about how and when to adjust consumptive behaviour.

The policy maker is in a vacuum as to what the actual trade-offs and constraints are. Water infrastructure managers try to meet demand, not knowing what the actual demand options or supply constraints are. At a point in time where the consequences of our actions are more apparent than ever, water resource management is severely limited by the lack of information.

By contrast, a well-informed water allocation would rely on a relatively long-term (multiple years) and large-scale (catchment size) prediction of the available water



Babylonian-style manual flow regulation, 2001.

resource, taking into account all sources – surface water, run-off, stored capacity (including groundwater), desalination and recycling capacity. Such water allocation would be informed by demand (urban, rural, industrial and environmental) patterns, and trade-offs, which would depend on water pricing and water trading.

Moreover, the water allocation policy would necessarily have to incorporate infrastructure limitations and potentially should allow for the evaluation of infrastructure investments. It should be adaptive and responsive as new information becomes available. This requires the prediction of water supply/demand over some length of time, and this is limited by the chaos-induced complexity inherent in the underlying climate/weather/population dynamics.

In such a situation, even a conservative prediction, enabling resilient decision making, is immediately constrained by accuracy and timeliness of data that must feed computer models. Also the reliability of these models plays an important role, and this too is derived from data.

One could envisage such a water allocation policy as the outcome of a rather large mathematically stated, hybrid and heavily constrained, computational optimisation problem. By comparison, present water allocation policies are merely Sumerian.

The computational and algorithmic techniques to tackle such large-scale problems are within present technological reach, (some of the real recent advances in this area are developed within NICTA and IBM) but the measured data to make this a meaningful endeavour are largely lacking.

On a smaller scale, our own work has focused on improving the efficiency of bulk irrigation distribution, from dam to farm, by upgrading the existing civil infrastructure with an information infrastructure. A typical manually operated system of open channels is managed so as to oversupply water because the penalty of undersupply is crop loss. A water-distribution efficiency of between 50 and 70 per cent is considered good practice – which means less than 70 per cent of the water released from a dam goes

It is essential to modernise the water infrastructure so as to improve water efficiency and in general achieve a more sustainable socio-economic and environmental water management outcome within the ill-understood constraint of the available water resource. Irrigation is not a bad place to start.

onto a farm. Evaporation and seepage account for around a third of these losses, the rest is a combination of measurement errors and unused water.

Researchers at the University of Melbourne and NICTA in partnership with Rubicon Systems Australia have developed a system where the existing in-channel flow regulating structures are replaced by networked sensors and actuators. Using data-mining techniques, the sensor data enable the control of the channel dynamics in real time to achieve near on-demand water distribution that matches supply with demand and maintains channel water levels, which is the main other quality-of-service requirement in a gravity-fed flood irrigation network.

The water flow and level data derived from the sensor network also provide more detail about the non-management losses, evaporation and seepage, and enable more targeted channel maintenance.

The next logical step in this development of information-rich water management is to link water supply directly to crop demand, so as to achieve more crop per drop as advocated in the UNESCO World Water Reports. Our approach is to close an information loop between crops' water needs, measured and predicted soil moisture deficit and the water supply, so the crop orders precisely its own water needs.

The rationale is based on the essence of timing, linked to crop development, as the main driver for irrigation efficiency. Early results in prototype systems at the University of Melbourne's Dookie farm indicate that on-farm economic productivity can be significantly improved while greatly reducing water consumption.

There is much more that can be done – similar advances can be made in urban and industrial water settings.

Moreover, not all water is created equal, and keeping track of water quality is important. A system-engineering approach that considers the entire water system is overdue.

The present water for growth responses in Victoria for example involve both new civil infrastructure as desalination and the lining or replacement of some open channels but also the implementation of an information-rich infrastructure in irrigation as well as a more comprehensive water trading framework. These are steps in the right direction.

In this line, building on Australia's unique position as a first world country with a serious climate change issue, we have the opportunity to develop within Australia a world-leading climate change adaptation and sustainability technology with an appropriate regulatory framework of world-wide importance.

A comprehensive local response will be essential to Australia's own future, and has the capacity to generate significant export income and improve our national GDP considerably. It is time to rebuild our irrigation infrastructure and lift it from its Babylonian heritage into the information age. ◀

IVEN MAREELS FTSE is Dean of the Melbourne School of Engineering, a position he commenced in 2007. In 2008 he was the recipient of a Clunies Ross Award for his work smart irrigation systems. He has published four books, 125 journal publications and 225 conference publications and holds six international patents. His research interests are in large-scale systems, in particular with applications in water systems. He is also a Fellow of the Institute of Electrical and Electronics Engineers (USA), a member of the Society for Industrial and Applied Mathematics, a Fellow of Engineers Australia and a founding member of the Asian Control Association.

Information-age flow regulation network, 2005.



Speed management an issue of sustainable personal mobility

Our standard of living and our productivity as a nation owe much to road transport. However, like almost all of our inventions there are substantial downsides



By Ian Johnston

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We have long had a love affair with the car. It has given us the freedom to go where and when we want and it has significantly shrunk the 'tyranny of distance'. Similarly, the truck has contributed enormously to our economic growth and efficiency. The vast majority of freight is moved by road, taking the lion's share of the freight task because of its ability to reach all corners of our cities and regions in a timely way.

Our standard of living and our productivity as a nation owe much to road transport.

However, like almost all of our inventions there are substantial downsides. Road transport is a major contributor to greenhouse emissions, is a demanding user of a diminishing energy resource, impacts adversely on our urban amenity and is the single largest cause of death in the first four to five decades of human life. We have not managed these challenges anywhere near as well as we should have.

Let's focus on safety, which has unquestionably improved enormously but has not begun to approach its potential. We have reduced road-crash death rates from more than 30 per 100,000 people in 1970 to about eight today. Not only rates but absolute numbers have fallen – from more than 3600 deaths in 1970 to fewer than 1500 last year.

But for every death there are still 10 to 14 serious injuries and the impact of both reaches beyond the victim to extended families, circles of friends and workplaces. Almost all Australians know someone personally affected by a road crash. Safety gains are getting smaller and harder to achieve. It is difficult, in the light of the current 20,000 annual deaths and serious injuries, to understand the continuing indifference on the part of the community and its leaders.

Vehicle safety improvements are a significant and ongoing contributor to the reduction of road crash injuries in Australia. Great gains have been made in crashworthiness from the 1950s when Ralph Nader blew the whistle on the auto industry in his book *Unsafe at any Speed*.

An international regulatory process requires manufac-

turers to include features such as seatbelts, airbags, collapsible steering columns, engines that slide under the passenger compartment in a head-on crash – and so on through an extensive list. In more recent years the focus has moved from crashworthiness to crash prevention with the advent of anti-lock brakes, electronic stability control and adaptive cruise control, for example, not all of which have yet become the subject of regulation despite compelling evidence of effectiveness.

The international regulatory process moves like treacle. The globalisation of the vehicle industry has slowed progress. Rule-making is greatly influenced by the global market and tends toward lowest common denominator. Second, manufacturers are given several years to prepare for the mandatory adoption of an innovation and only then do the new, safer vehicles begin to percolate through the vehicle fleet.

With an average vehicle age of more than 10 years it takes more than a decade before a safety innovation has reached saturation. This could, of course, be short-circuited by the market demanding features ahead of the regulations.

One way is for manufacturers to market the features itself, but this typically happens only in the form of options for the luxury models in each range. Safety is not seen as a big selling point.

A second way is for the big fleet buyers (governments and corporates) to specify safety features in their fleet orders, which should be a given viewed from an OH&S perspective. Despite many recommendations to this effect, no government in Australia has done so. The decisions rest on considerations of direct fleet costs only, reinforcing the conclusion that society accepts the road toll as a necessary price for mobility.

As Newton discovered centuries ago, kinetic energy is the product of mass times the square of the speed. While vehicles have become safer, the common impact speeds frequently result in forces well beyond those the human body can tolerate. Colliding with a pedestrian at more than

40 kilometres per hour or being struck, in a side impact, at more than 50km/h results in a high probability of death.

The first principle of injury reduction is reducing impact forces to those the human body can tolerate. Manufacturers address the mitigation of kinetic energy but do nothing about speed, which dominates the amount of energy to be managed!

Year upon year the top speed capability and the acceleration performance of cars increases. The industry markets primarily on power and performance, aided and abetted by motoring journalists whose opening paragraph almost always refers to the time it takes to get from 0 to 100km/h.

The speedometer of a modern car shows a top speed between 220 and 300km/h, depending on the model, with the maximum open road speed limit (outside the Northern Territory) being located around top-dead-centre. Well over half the gauge is designed to measure illegal behaviour!

The manufacturers run the argument that speeding is entirely under the control of the driver, reminiscent of the gun lobby's argument in the film *Bowling for Columbine*.

The industry and all those who depend upon it go to great lengths to promote the excitement and sheer joy of speed. There are, literally, no vehicle safety design rules pertaining to top speed capability or acceleration performance – meaning governments are complicit on this most critical safety element, perhaps unsurprising given the importance of the industry to the global economy.

In turn, the community seems not to accept that moderating travel speeds is warranted. The common allegation

that intense speed enforcement is simply revenue-raising further reinforces this conclusion. It is a fascinating irony that research is now focusing on in-vehicle speed management technologies to moderate speeds to the limits signed; typically via driver-assist modes and continuing to ignore the speed parameter in vehicle design.

There is a considerable body of research that shows great gains in fuel consumption and significant reductions in emissions at lower average travel speeds. Perhaps we should tackle speed management as an issue of sustainable personal mobility – moderating speed is a win for the environment as well as for safety without compromising mobility.

Mobility is not getting from A to B in the minimum possible time – it is having access to all the facilities and services one wants at a time of one's own choosing. It may be more politically opportune to piggyback upon the sustainability movement than to seek to open the sacred topic of the industry's promotion of speed to meaningful debate. ◀

PROFESSOR IAN JOHNSTON AM FTSE is an Adjunct Professor at the Monash University Accident Research Centre and was its Director until retiring at the end of 2006. Ian serves on the Core Advisory Group for the World Bank's Global Road Safety Facility, is a Director on the Board of the Driver Education Centre of Australia, is Deputy Chairman of Australia's National Transport Commission and is an Associate Editor of the scientific journal *Accident Analysis and Prevention*. He has worked in the traffic safety field for some 40 years and has received several national and international awards for his work, including an Order of Australia in 2007.



Real world crash investigations provide valuable, in-depth information to help improve vehicle safety.

Investing in the managers that manage the investments

What confidence is there that these new investments will be managed effectively to deliver the expected economic, environmental and social benefits over the long term?



By Melinda Hodkiewicz

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The centrepiece of this year's Federal Budget is \$22 billion over four years for new asset-intensive projects including rail, highways, ports, schools and broadband. As impressive as this is, it is dwarfed by current levels of capital expenditure in the minerals and energy sector. Woodside's Pluto LNG project has an announced capital cost of \$12 billion. In the six months to April 2009, 18 major minerals and energy projects with a capital expenditure of \$5.2 billion were completed.

What confidence is there that these new investments will be effectively managed to deliver the expected economic, environmental and social benefits in the long term?

The *National Infrastructure Priorities Report* by Infrastructure Australia recommends that there needs to be "objective, specific, evidence-based and data-rich identification of deficiencies with the condition, operation and services provided by infrastructure". In the text and tables of the report there is no mention of the need for investment in developing the organisational and managerial competences that will make evidence-based decisions possible. Is there an implicit assumption that these capabilities exist and are employed effectively and sustainably at all levels in our asset-owning organisations?

Asset management is the "systematic and coordinated activities and practices through which an organisation optimally manages its assets, and their associated performance, risks and expenditures over their lifecycle for the purpose of achieving its organisational strategic plan".

The past six years have seen an explosion of activity including the development of new institutions

representing various asset management communities and a plethora of standards, guidelines, manuals and related publications. Most of our major infrastructure and resource organisations have set up internal asset management or asset reliability groups.

Universities are also involved, responding to market demands for asset management and reliability engineering education with new postgraduate units and degree programs. These new postgraduate programs recognise that asset managers need to combine technical understanding of asset reliability, safety and performance with financial and managerial skills. Particular emphasis is given to the development of technical skills in risk management, reliability and life-cycle costing, combined with decision making, strategy development and implementation, change management and communication.

These programs are for those leading change in their organisations. Participants are experienced engineers and managers involved primarily with the in-service phase of the asset life cycle and are actively involved in developing and embedding sustainable asset management practices in their organisations. They bring rich experience in managing assets.

At the University of Western Australia the average age of participants in the Business and Engineering Asset Management program is early 40s and they generally hold senior engineering positions or their management equivalent. Program participants work in a range of industries including oil and gas, mining, mineral processing, manufacturing, local government, and utility infrastructure. Some are engineering-degree qualified



and others have not previously attended university but hold positions with considerable budgetary and line-management responsibility.

The common link is their direct experience of working with the people that operate and maintain the assets. This collective experiential base is necessary for informed discussion about the challenges of applying tools and processes in the real-world and bridging the gap between theory and practice.

A whole-of-organisation approach to asset management requires breaking down the traditional barriers between those who develop asset strategy and those who execute it between manufacturers and asset users, engineers and non-engineers, and operations and maintenance. Asset managers must be able to communicate from the shop floor to the board room.

Assets deteriorate but it is the systems that support them that fail, sometimes with spectacular and unexpected consequences. This can damage an organisation's bottom line and reputation.

Good asset managers develop and implement the processes to ensure that evidence-based, reliability focused decisions minimise risk and deliver value sustainably. Potential for improvement is huge and the benefits substantial. The capital expenditure of investments we are currently making is only a fraction of the total cost of ownership of the assets.

Asset managers are one of the keys to delivering value for these new investments through the asset life cycle. Are you investing in them as well? ◀

RELEVANT READING

- Institute of Asset Management – www.theiam.org
- Asset Management Council – www.amcouncil.com.au
- Asset Management in Local Government at the IPWEA – www.ipwea.org.au
- 'The evolution of Asset Management' 2007 White Paper from IBM Global Business Services available at www-304.ibm.com/jct03001c/industries/travel/us/detail/resource/G096505L02851R53.html

DR MELINDA HODKIEWICZ is Associate Professor and Discipline Group Leader for the Engineering Asset Management Program at UWA. Following a materials degree at Oxford University she worked for many years in the mining industry in operations, commissioning and maintenance roles. In the late 1990s she completed a PhD in condition and performance monitoring. Currently she coordinates multidisciplinary research projects, is responsible for UWA's Masters of Business and Engineering Asset Management program and works with institutions and organisations in Australia and overseas to develop guidelines for Asset Management.

CAETS STATEMENT ON GLOBAL RESOURCES

The 2009 CAETS Convocation in Calgary, Canada, in July addressed the grand challenges and opportunities associated with the sustainable management of natural resources and concluded that new approaches are required to managing global resources and the supply chains they feed, to ensure that humanity's needs are fulfilled for current and future generations.

The 2009 CAETS Statement, 'Global Natural Resources – Management and Sustainability', said issues related to energy, water management, forestry, and mining/minerals must be considered in an integrated approach and in harmony with nature, which examines their interdependencies and taps the cross-sector opportunities for novel strategies, processes, technologies and solutions.

Covering energy, forests, water management, mining and minerals, the Statement makes 17 recommendations and concludes that the engineering challenges associated with sustainable resource management are indeed vast – but the opportunities are likewise enormous.

"With rapidly depleting natural resources, many non-renewable, we must harness the power of engineering to develop new solutions, supported by clear policies and regulatory frameworks and with appropriate consideration of the necessary social implications," CAETS says.

"To succeed in meeting these challenges, the engineering profession will work with society, industry, public organisations and politicians."

The 2009 CAETS Convocation examined the transition to sustainable resource management on a global scale. The CAETS academies are committed to bring engineering knowledge and skills to lead and accelerate this transition, and to design and deploy the innovative technologies, systems and organisations needed for sustainability in a changing world.

CAETS is the International Council of Academies of Engineering and Technological Sciences.

Full statement at www.atse.org.au/index.php?sectionid=30

2009 ATSE SYMPOSIUM: REGISTER NOW

Registrations are open for ATSE's 32nd National Symposium – 'Future-Proofing Australia – Rising to the Challenge of Climate Change'. It will be held at the Sofitel Brisbane Grand Central, 16 and 17 November 2009.

The Symposium will address one of the most important issues our nation faces. Some of Australia's leading authorities – from the private and public sectors, as well as researchers – and overseas speakers will address key topics. This will be a key conference on this vital topic when the most current information will be available.

Fellows are invited to attend. As ATSE President Professor Batterham says: "It's an event you can't afford to miss. I look forward to seeing you in Brisbane in November."

The registration brochure, including the full program, and discounted accommodation options are available at www.atse.org.au/index.php?sectionid=1019

Nuclear power “must be considered” for energy security

Australia needs a major increase in baseload electric power to achieve energy security and nuclear power must be considered as an option to achieve it, according to the Academy.

ATSE says in a recent media release that energy security is a real issue for Australia and the additional power generation capacity required is independent of climate change and will still be needed even with greater focus on energy efficiency and conservation measures.

It says governments must establish the necessary long-term, stable policy settings to ensure large scale investments are made in new generating capacity, where there is a current “investment drought”.

ATSE has prepared two major reports

this year on the subject of developing and deploying advanced technology to secure sustainable energy supply.

The first, *Energy Technology for Climate Change – Accelerating the Technology Response*, was launched in January by the Minister for Resources and Energy, Martin Ferguson.

It said Australia needed to invest some \$6 billion on RD&D on new power generation technologies by 2020 to meet the challenge of achieving projected carbon dioxide reductions – a call supported substantially by the Government’s 2009 Budget decision to invest \$4.5 billion to support the growth of clean energy generation and new technologies and to reduce carbon emissions and stimulate

economic activity through the Clean Energy Initiative.

The second report, containing a communiqué resulting from a three-day International Workshop in Melbourne on the major challenges in accelerating technological change in electricity generation, noted that Australia faced inevitable electricity rationing and the threat of blackouts without large-scale investments in new power-generating capacity.

The international contributors to the workshop argued that nuclear energy would need to be part of future base-load energy mix if deep cuts in GHG were required. They suggested reduction or removal of the technological, regulatory and other risks that currently shape government policy on nuclear energy. ◀

Both reports are available on the ATSE website:

Energy Technology for Climate Change – Accelerating the Technology Response (www.atse.org.au/index.php?sectionid=1261)

Electricity Generation: Accelerating the Technology (www.atse.org.au/index.php?sectionid=1313)



Intense discussions at the International Workshop on accelerating technological change in electricity generation.

MORE INTERDISCIPLINARY RESEARCH, SAYS ATSE

Scientific research in Australia needs a greater focus on cooperation across research disciplines, according to the Academy.

ATSE says that many of the major research questions of the future will require an interdisciplinary approach, but the current research structures and funding do not always accommodate this need.

The Australian Research Council’s ARC Centres of Excellence program should “overtly encourage and reward” interdisciplinary research, ATSE says in its recent submission on the ARC program, which it describes as “outstanding”.

ATSE also argues that the program should embrace research proposals with a “higher than normal” element of risk, provided the risk is evaluated against potential reward and any successful outcome for the research proposed will deliver significant benefits.

ATSE expresses a concern that the objective of the program to require Centres to demonstrate ‘scale and focus’ may discriminate in

favour of problem solving research and against groups working on complementary enabling technologies (eg: nanoscience, mathematics, etc) which might find a broad range of applications. The scale and focus objective would also limit the spread of the program into many humanities and social science areas.

It argues that the calibre and reputation of the researchers involved in a proposed Centre of Excellence is more important than the detail of their proposed research.

“Selecting and supporting centres that are able to attract and retain world-class researchers, capable of executing whatever research priorities emerge” is most likely to achieve best outcomes, says ATSE.

ATSE also suggests that “sustainable national benefit and enhanced reputation” will only be achieved if early career researchers are included prominently in research teams.

The full ATSE submission is at www.atse.org.au/?sectionid=1157

ATSE gets CAETS support for international energy project

The Academy's focus on low-emission power-generation technologies to help Australia – and the world – better meet the challenges of climate change have gained international traction through CAETS, the International Council of Academies of Engineering and Technological Sciences.

As a consequence, ATSE will lead an international CAETS program over the next year to further develop evaluation skills and levels of public investment for the benefit of governments and economies across the world searching for sustainable power generation solutions.

The issue of climate change is receiving considerable attention internationally. While governments are setting targets and providing funding support for low-emissions technology research and demonstration, it is clear that further and larger investments will be required to deploy these technologies at large scale. There is a need to accelerate the deployment of these technologies if target levels of greenhouse gases are to be met.

Current public policy reflects to varying degrees this need to accelerate technology deployment but it is not yet well informed on the practicalities of the implementation pathways.

This has been a key driver in ATSE's well-publicised work in the area, which moved to a new plane during the recent CAETS Convocation in Canada, where the Academy received strong support for its proposal to extend its work on evaluating alternative power technologies.

Titled *Evaluation of Strategies to Deploy Low Emissions Technologies for Electric Power Generation in Response to Climate Change*, the project will involve an international workshop around the end of this year and report back to the CAETS Council in June 2010.

The ATSE project aims to:

- raise the level of debate on the merits of and the need to rapidly deploy low-emission technologies;

Resources Minister Martin Ferguson launches ATSE's report *Energy Technology for Climate Change*.



- develop a common language to evaluate and compare alternative technologies and portfolios of technologies being considered for national implementation; and
- develop a generalised financial framework to assess the deployment of alternative technologies to meet climate change targets.

ATSE expects the results from the financial assessment framework will be used to:

- provide an unbiased assessment of alternative technologies to meet climate change targets;
- assist governments to identify public policy support for alternative technologies;
- inform private industry investment decisions; and
- consider the levels of public investment required to accelerate the deployment of a portfolio of alternative, especially new technologies.

ATSE says the financial framework could be used to evaluate alternative technologies at various levels of investment detail, including – for each technology – consideration of various investment pathways involving a series

of embedded investment alternatives, that can be used to position each technology for commercial deployment. The study could also investigate the net effect on employment of the investment in support low-carbon technologies.

This proposal grew out of two earlier ATSE domestic initiatives.

The first was the study leading to the December 2008 ATSE report *Energy Technology for Climate Change: accelerating the technological response*, which was restricted to stationary energy generation and considered only capital costs.

The second was a three-day International Workshop in Melbourne from 31 March to 2 April 2009 attended by representatives from four engineering academies – Japan, Germany, South Africa and the United Kingdom – and Australian delegates expert in their field.

The ATSE project backed by CAETS was developed in conjunction with those four Academies, plus the Canadian Engineering Academy and the Indian National Academy of Engineering. ◀

Can private sector R&D feed the poor?

Registrations are open for the Crawford Fund 2009 annual international conferences on vital aspects of global development. The 2009 event – World Food Security: Can Private Sector R&D Feed the Poor? – will be held in Parliament House, Canberra, 27-28 October 2009.

"Last year's world food price crisis activated much-needed international and Australian attention, action and funding to improve world food security," said Crawford Fund Chairman Hon Neil Andrew AM FTSE.

"Fundamental to these efforts is the application of agricultural research and development. But what is the private sector's role in this vital task?

"The Crawford Fund has brought together the best thinkers on the intersecting roles of the private, the not-for-profit and the public sectors in global food security to inform

corporate and public decision-making.

"Now is the time to encourage the private sector – from large multi-nationals, to smaller companies and individual farmers – to make a significant difference to food production in developing countries, in partnership with governments and the not-for-profit sector.

"I hope to welcome you to our conference and I'm confident that lively debate will highlight the options and issues involved and the important role of international agricultural research," he added.

The conference will involve the traditional Parliamentary one-day conference, a conference dinner and a Parliamentary breakfast, each featuring different speakers and providing further opportunities for gaining new perspectives, feedback and networking.

Keynote speakers include:

- Dr Marco Ferroni, Executive Director of the Syngenta Foundation for Sustainable Agriculture;
 - Professor Philip Pardey, an internationally renowned Australian agricultural economist;
 - Dr Prabhu Pingali, of the Bill and Melinda Gates Foundation; and
 - Dr Namanga Ngongi, President of the Alliance for a Green Revolution in Africa.
- Registration at www.crawfordfund.org/events/conference09.htm ◀

The Crawford Fund is an initiative of ATSE. Its mission is to increase Australia's engagement in international agricultural research, development and education for the benefit of developing countries and Australia.

ATSE BACKS COMMONWEALTH COMMERCIALISATION INSTITUTE

The Academy has welcomed the Government's intention to assist the commercialisation of research, given the current absence of a suite of appropriate support programs for commercialisation.

In a submission on the proposed Commonwealth, following review of the proposal by a number of ATSE Fellows expert in the area, the Academy made a number of recommendations on the role of the CCI.

It notes that the Australian Institute for Commercialisation and InnovationXchange are current successful operations and the CCI should not duplicate their roles.

ATSE submitted that the CCI must:

- actively support a system integration model of commercialisation (that is inclusive of, but broader than, the research push model);
- review and then adopt world's best practice for commercialisation;
- facilitate engagement between universities

and firms;

- take a strategic role in the further development of foresighting and road-mapping exercises and actively support the identified commercialisation potential;
- provide resources to support high level expertise in universities that will facilitate commercialisation and collaboration activities;
- identify the world's best practice in entrepreneurship management programs and implement them in Australia;
- identify barriers to commercialisation and remove such barriers;
- establish some National Innovation Challenges and fund worthy commercialisation activities under these National Innovation Challenges; and
- appoint a governing board composed primarily of people who have achieved success at commercialisation. ◀

ATSE's submission is at <http://www.atse.org.au/?sectionid=1157>

WA Division Education Seminar

'Science and Engineering Education: Towards 2030'; the WA Division's Annual Seminar, will be held on 15 October at Curtin University of Technology.

The keynote address by Emeritus Professor Mary O'Kane FTSE, Chief Scientist and Scientific Engineer of NSW is titled 'The Challenges facing Science and Engineering Education during the Next Two Decades'.

The program includes presentations on a variety of education initiatives and issues such as: 'The National Curriculum – Science'; 'CSIRO Scientists in Schools Program'; 'The ATSE STELR Project' (by Peter Pentland, STELR project manager); 'Teacher Education – the Collaborative Science Project'; 'The Perspective of Engineers Australia'; 'University Engineering Education – Improvement and Change'; and 'VET's Role – Potential and Prospects'.

150 attend SA Climate Change Forum



Mike Rann with
Robin Batterham.

ATSE's South Australian Division hosted 150 delegates at a one-day forum in Adelaide in July to present to politicians, senior public servants and stakeholders the latest scientific and engineering thinking relevant to SA's adaptation to climate change.

Supported by the SA Premier's Climate Change Council, the Adapting to Climate Change forum focused on the latest climate change predictions for SA, progress on developing a national adaptation framework, and opportunities and challenges in water security, infrastructure, agricultural production, renewable energy, energy efficiency and transport.

The forum was opened by Premier Mike Rann, who emphasised that adaptation to climate change needed to be the prime focus, and the ATSE President, Professor Robin Batterham, delivered the keynote address.

Professor Batterham noted that the fundamentals of long term energy demand must be balanced against the imperatives of decarbonising our emissions profile.

While much was happening in renewables, a recent study of the experience of Spain highlighted the need for a more expansive approach, he said.

Some very large changes would be needed – as ATSE had outlined in its recent report *Energy Technology for Climate Change: Accelerating the Technology Response*.

He questioned whether renewables,

efficiency and adaptation should be the main path or whether we also need nuclear, carbon capture and storage, as well as much more encouragement to overcome the technological "valley of death" of major new developments, such as geothermal?

Professor Barry Brook, Professor of Climate Change at the University of Adelaide, presented a wide-ranging review of the global climate change picture with commentary on climate change predictions for SA and its major impacts. He outlined a case for consideration of a wide range of mitigation options.

In regard to climate change and reducing carbon emissions, he challenged many in the environmental movement to think again about nuclear power. He argued that in the future Australia would need more energy, not less, and the only way to meet increased demands for power would be an "inconvenient solution", namely nuclear.

Fast nuclear reactors should be part of the energy solution, given that they now burned up to 99 per cent of the nuclear fuel, leaving only a small amount of relatively short-lived waste, he said.

Professor Len Stevens AM FTSE reviewed the ATSE 2008 study *Assessment of Impacts of Climate Change on Australia's Physical Infrastructure*. The study concluded that potential impacts include the effects of extreme rainfall, sea level rises and storm surges (impacting on low lying coastal

developments & associated transport links), drought, bush fires and temperature extremes (impacting on electricity supply and communications), and extreme winds, drought and fire (impacting on our built environment).

Dr Peter Hayman of the SA Research and Development Institute explored the adaptation challenge for agriculture in SA, noting that agriculture was exposed and sensitive to a warmer and water-constrained future. He noted there was a high degree of adaptive capacity within the agricultural sector and described lessons learnt regarding risk, resilience and thresholds from dryland grain farming and irrigated wine grape production in SA.

Dr John Burgess FTSE reviewed another 2008 ATSE study, *Energy Technology for Climate Change: Accelerating the Technology Response*, which showed that for new technologies to be successful, very large investment would be required.

Professor Alan Pears AM outlined the significant potential for cost-effective energy efficiency improvement across our economy. His focus was on non-transport energy, which is responsible for around half of Australia's emissions. Strategies for increased energy efficiency represented the largest single opportunity for rapid and cost-effective climate change response, he said.

Dr John Wright FTSE described an ATSE study that considered the Australian alternative transport fuel situation and how it might change in the decades out to 2050. Then he explored the energy/transport situation specifically in South Australia pointing out that SA transport emissions have increased, contrary to the national trend, which has been decreasing.

In the final paper in the Forum, Tim O'Loughlin of the Department of Premier and Cabinet described the challenges SA faced to maintain its leadership position in attracting renewable energy investment, given the SA Government's new target of having one-third of its electricity generation coming from renewable sources by 2020. ◀

Technological disruption in health care

The NSW Division of ATSE will hold a half-day seminar titled 'Impact of Technological Disruption on Health Care in Australia' in Sydney on 7 October from 8.00am to 1.45pm.

The seminar reflects that:

- the health-care system is under great pressure from a rapidly ageing population, an ageing health workforce and ever increasing community expectations;
- expectations drive the take-up of new technologies which bring health benefits but frequently at significant cost; and
- just maintaining business-as-usual will not be an option.

The seminar organisers note that some technologies have the potential to streamline the health delivery system, increasing both

efficiency and positive outcomes but – to get the best benefit – a restructuring of the system will be necessary.

Speakers will address issues of long-term national importance of interest to various stakeholders – governments; large, medium, and small corporations; health-care unions; and the education and research sectors.

The seminar will provide an unrivalled opportunity to discuss issues with an audience drawn from company boards and senior management, government policy advisers, financiers, researchers, and consultants. ◀

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LETTER

COMMUNITY OPPOSITION TO NUCLEAR POWER?

I am a retired engineer and a member of the 2006 Switkowski nuclear energy review (UMPNER). I have since given numerous public talks (at conferences, technology institutions, university students, Rotary and Probud clubs, and so on).

I cannot support the view, too often taken as a given, that "community opposition to it (nuclear power in Australia) is so strong and it would take 10 years to go down that track".

My experience is the opposite. Once the facts are explained clearly and honestly I find almost universal appreciation for the understanding given of a technology widely and safely used by many other countries. I have detected virtually no ongoing opposition, indeed many people express surprise that Australia denies consideration of nuclear power while exporting nearly 40 per cent of the world's uranium!

One well-propagated 'urban myth' has it that nuclear-generated electricity is

hugely costly. Certainly in Australia it is more expensive than coal-generated electricity – by 30 to 50 per cent, depending on how capital and risk are treated. However, with carbon pricing and the costs – yet unknown – of carbon capture and storage, that relativity will change.

John Citizen would very soon ask searching questions of any government which failed to consider the least-cost options for baseload electricity once the price goes up – as it certainly will.

Baseload electricity – essential for industry and commerce – excludes renewables such as wind, solar and wave, which are naturally intermittent. Geothermal is promising but still unproven as economic for large-scale baseload supplies. Nuclear power, which safely and with minimal pollution provides 15 per cent of the world's electricity, certainly passes that test.

– Martin Thomas AM FTSE

ATSE AT HEALTH LONGEVITY WORKSHOP IN PARIS

A 12-member Australian delegation led by Professor Greg Tegart AM FTSE will participate in an Australian Europe Workshop on Smart Technology for Healthy Longevity in Paris, 5-6 October 2009.

The workshop will be followed by a program of technical visits, which will provide additional insight into possible areas of future cooperation.

The workshop and technical visits will bring together key researchers and leading practitioners and participants to discuss current, identify future directions for research and implementation and explore potential future areas for cooperation between Australia and Europe.

Leading researchers from Australia, France, Germany, the UK, Czech Republic and the Netherlands will participate in the workshop and discuss the application of converging technologies to improve the health and wellbeing of ageing populations. The discussions will provide a strong input to the current ATSE Project on the same topic, also being led by Professor Tegart.

The workshop and technical visits will be hosted by the French Academie des Technologies (NATF) with the cooperation of Euro-CASE (the European Council of Applied Sciences, Technologies and Engineering, which is a European organisation of national academies from 21 European countries).

ATSE acknowledges the funding received from the Australian Government under the International Science Linkages programme, as part of the EC-Australia S&T Cooperation Roadmap. ◀

Paul Willis
and guests
chat with
students
at the Fish
Bowl dinner.



Amazing science array at Melbourne Youth ANZAAS

By Mike Murray

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An amazing array of science exposures was organised for the 54 students from Australia and New Zealand who participated in Youth ANZAAS in Melbourne in July, staying at Ormond College at the University of Melbourne.

The Charles Darwin anniversary and the influence that *On the Origin of Species* had on thought in science and humanities was a key theme, so Day 1 had the students straight into a practical session (entitled 'From Darwinian Variation to Modern Molecular Analysis') in the genetics department at the University of Melbourne.

Then it was off to the Gene Technology Access Centre at University High School for lunch with the Governor of Victoria, Professor David de Kretser AC FAA FTSE, and to hear him talk on the genetics and functioning of the sexual organs in the human male, with emphasis on our understanding of infertility (so not to forget Darwin's other book, *The Descent of Man: Selection in Relation to Sex*).

After lunch Professor Phil Batterham gave a presentation on the present day interaction between climate change and natural selection. Climate change was also lurking in Dr Roger Rassool's demonstrations into Adaptability, Energy and our Environment where – incidentally – the participants overwhelmingly concurred that nuclear energy was central to the solution to our atmospheric CO₂ problem.

After dinner in Ormond's dining hall, the students were transported back in time to the mid-19th Century by Professor Frank Nicholas, a veterinary geneticist and,

more importantly on this occasion, co-author of the book *Charles Darwin in Australia* – his topic for the evening.

On Day 2 the students headed for Clayton where the Australian Synchrotron loomed large as one of the week's highlights. It didn't disappoint. The Synchrotron was shut down for regular maintenance, which allowed the ANZAAS visitors a seldom treat – they could visit the tunnels to examine the linear accelerator and the injection systems and walk around the ring itself and view the impressive bending magnets and all the complex ancillary equipment. Several participants thought at the outset that the Synchrotron was specifically a device to assist the physical sciences and related technologies and were amazed to find the implications it has for the biological sciences and medicine.

After lunch with the Monash Engineering Society there was a tour of the engineering facilities, which included the high voltage laboratory (replete with spectacular discharges) and the nanotechnology laboratory to learn about tiny motors being designed to navigate capillaries in the human body.

The Monash visit concluded with two presentations, one by Professor James Whisstock touching on the value of the synchrotron to medical research and another by Professor Neil Watkins on various cancers and potential treatments.

The cancer trail continued on Day 3 with a visit to the Peter MacCallum Cancer Centre where the 'fly lab' proved a favourite. Later a visit to the Melbourne Museum included a behind-the-scenes tour. The rest of Day 3 was devoted to the lighter sides of scientific method with the University of Melbourne MUPPET show and CSIRO's 'Science of Dating'.

Day 4 began at the Walter and Eliza Hall Institute for

Searching for the next generation scientist

ATSE Director, STELR 'champion' and Monash University Chancellor Dr Alan Finkel spoke at the National Press Club in Canberra in a televised address on 19 August.

His address was supported by Australian Science Innovations, chaired by ATSE Fellow Dr Mark Toner, which organises the Australian Science Olympiads (see *ATSE Focus* 156). ATSE also supported the event, with the Board and guests attending the lunch. This is an edited version of the address.



I see support for the next generation of Australian scientists and technologists as support for the future of Australia, but the current situation is not as rosy as it might seem. During the 1980s and the 1990s the number of Year 12 students choosing one of the fundamental science subjects – that's physics, chemistry, mathematics and biology – declined by about 50 per cent. The numbers have not improved since then so our talent pool is shrinking.

Where will the next generation of Australian scientists come from? How are we going to reap a rich crop of Australian scientists? I want to outline a plan for cultivating the next crop of Australian scientists, drawing on my own experience as a home-grown scientist-entrepreneur.

My plan has three components:

- 1 You reap what you sow – we need to cultivate student interest during their school years by exposing them to well-taught compelling science;
- 2 We need to advertise science careers to those students so that our science-based industries will reveal the rich suite of career opportunities that are open to students if they choose science; and
- 3 We need to market our products.

When I was a boy the articles about the moon mission fuelled my passion for science. Today, science has advanced to frontiers that would have seemed like science fiction back then. We have deciphered the DNA codes of some of the most remarkable creatures that ever lived on earth: from woolly mammoths to the archaea cells that live off carbon dioxide in undersea volcanoes and turn it into methane.

Having decoded life, we are poised to redesign it. Witness the \$600 million dollar deal Exxon Mobil has just struck with Craig Venter to create a species of algae that will directly produce and excrete crude oil.

Cultivating secondary-school science

There are dozens of national activities that serve to inspire and teach – such as the Science and Engineering Challenge; National Youth Science Forum; CSIRO's Scientists in Schools, the Science Olympiads and the Rio Tinto Big Science Competition.

These extracurricular programs play an outstanding role, but none reaches all students. If we want to increase the size of our crop we can't just focus on the prize pumpkins – we need to fertilise the entire crop. In other words we need a program that is part and parcel of the curriculum and that captures the imagination of all students.

ATSE is currently road-testing just such a program. As a national body consisting of distinguished engineers, doctors and scientists, the Academy is extremely concerned about training the next generation.

Two years ago I was assigned the task of developing a plan. The Academy is a national body, so our plan had to have national reach, potentially engaging with every student in the country. It soon became clear to me that there was one important avenue that had not been fully explored by existing programs – relevance.

According to the Relevance of Science Education international comparative survey, there is a consistent problem in developed countries: young people do not see the relevance of science in their lives, even though they are surrounded by science and technology – in their iPhones and Xboxes, in their classrooms and living rooms, in their tennis racquets and swimsuits, at the doctor's and in their food.

If science and technology is largely taken for granted, we need to ask: what do young people care about? A survey of 14-year olds by the Australian Childhood Foundation found that, after you eliminate highly

personal concerns such as losing a parent or being bullied in the school yard, the top of the list for young people is growing up in a world without water, a world suffering from climate change. Separately, in a British poll earlier this year, 75 per cent of 16 to 24-year-olds surveyed “felt that it is important for them as an individual to do something about climate change”.

From these surveys we identified climate change as a hook with which to grab young peoples’ interest. But climate change itself is too difficult an area of science from which to teach the fundamentals. The challenge shifted to finding a link to climate change that would be suitable for teaching physics, chemistry, maths and biology.

We identified a logical link – climate change is caused by global warming. Global warming is caused by carbon dioxide emissions. The biggest sector of our economy to emit carbon dioxide is the fossil-fuel generation of electricity. If all that fossil-fuel electricity were replaced by renewable energy we would substantially reduce the level of carbon dioxide emissions.

Renewable energy technologies such as wind, solar and biofuels are extremely suitable for teaching the fundamental sciences and young people seem to find them intrinsically interesting, as do many adults, including teachers.

So at the Academy we adopted renewable energy technologies as our education context.

The program goes by the auspicious acronym of STELR (Science and Technology Education Leveraging Relevance). STELR was initially funded by ATSE and some of its Fellows, the Academy of Science, and the Victorian Government. STELR is complementary to the Academy of Science’s ‘Science by Doing’ program.

For the students, it’s all about engagement, hands-on experiments and drawing conclusions from the evidence that they have personally gathered. They learn to look at data rather than jump to conclusions – to answer questions such as: can a solar panel at home actually supply your real electricity needs? It’s one thing to run a few light globes. It’s quite another to power your plasma TV.

So far our report card has been good. A formal evaluation of the first year of the STELR program showed a substantial increase in the percentage of students who rated science as relevant to their lives and who enjoyed learning science at school.

The STELR program appeals broadly, to boys and girls, to nerds and jocks, because it has a strong societal context. It exposes students to climate change issues, such as the difficulty of obtaining international agreement on corrective action and the moral dilemmas caused by farmers switching from growing food to growing fuel.

STELR has secured the backing of the Australian

Government, with its funding, will be rolled out to 180 secondary schools across Australia in 2010. The success of STELR illustrates why it’s so important for governments at all levels to support new approaches to teaching science.

‘Advertising’ science career opportunities

For newly minted science graduates, job opportunities naturally break into three categories: a lateral shift to a non-science career, pursuit of a science-related commercial career, or a beeline into scientific research.

There’s no doubt that for the sideways shifters who follow a non-science career path, science literacy is empowering – understanding the fundamentals of how the universe works, making decisions based on evidence and the ability to think with numbers are essential foundations.

For those who wish to build on their science degree in a commercial career there awaits a huge breadth of science-based industries developing the next generation of everything from malaria drugs to muesli bars; iPods to electric cars, bank codes to suspension bridges. The world we live in is underpinned by science. It is no surprise that there are lots of science-related jobs.

A minority of our science graduates will take the beeline to research. Perhaps part of the reason for the low uptake rate is a lacklustre image of what doing research is all about, but there is much more to research than the iconic beaker and pipette – think of the Square Kilometre Array (SKA), the Australian Synchrotron and my personal favourite: analysing the human brain.

Governments can – and do – fund inspirational projects. Universities and research institutions provide the framework and, at their best, minimise red tape, maximise opportunities for collaborations, and establish the research infrastructure. But how many young people know about career opportunities with the SKA, the Synchrotron, or

What makes STELR different?

- STELR is single-minded about using climate change and renewable energy technologies as a highly relevant context to excite the interest of students.
- STELR is very practical and hands-on. We give teachers classroom kits for the students, consisting of solar panels, wind turbines and the ingredients for producing small quantities of bio-diesel and bio-ethanol. We believe that it is important for every student to work directly with these technologies.
- STELR operates within the curriculum, because our goal is to reach every student in a year level, not just those who already have an enthusiasm for science.
- STELR supports teachers with two-days of training on modern, inquiry-based learning techniques and the principles of renewable energy.
- STELR introduces students to real-world, science-career professionals so that the students can see what the future might hold in store for them.

analysing the functions of the brain? Very few!

We're providing but we're not publicising – and that's where we need to do a better job on getting the message out about the exciting challenges in science, and the exciting and rewarding jobs that go with them.

Marketing science through science journalism

I often hear journalism criticised for being too shallow, too difficult, too sensationalist or too parochial. Years ago I remember reading about space exploration, medical advances and geology in popular science magazines and newspapers, and everything I read was understandable, plausible and exciting. Today, it's rare that I have that same combination of feelings after reading a science article in the general media.

What's changed? Are journalists and writers today less competent? Not at all. The problem is that they are facing a more difficult task. Science today is so much more complex than it was 30 years ago. The leading edge problems in most cases cannot be solved by an individual or by a thought experiment.

Take climate change. The predictions of the consequences of greenhouse gas emissions emerge from mind-bogglingly complex computer models.

We used to be able to tell stories about science in an engaging and enlightening manner. It's harder to talk about science in these terms today, because science is conducted in large teams and it's often highly specialised and highly complex.

I've discussed the challenges facing science journalism with Wilson da Silva, editor of *Cosmos*, the magazine and media organisation that he, Kylie Ahern, my wife Elizabeth and I co-founded. We have debated how best to deal with complex science and related questions: how do you portray in a meaningful way the people behind the science? How do you evoke passion without undermining credibility?

It's clear to us that science journalists need to be trained in science and in journalism. They need an understanding of the nature of science, the scientific method and critical thinking. These skills enable them to separate hype from reality, distinguish between a story that is newsworthy versus one that is baseless, and recognise robust science versus spin. Just as important, science journalists also need to know how to tell a story, entertaining and informing in equal measures.

Where do well trained science and technology journalists come from? A few of our universities offer double degrees in science and journalism. At *Cosmos* we've gone the next step. We offer internships to help equip new science journalists with their professional skills. The benefits of such on-the-job training are well recognised in Germany by the Bosch Foundation. Its Science Journalism Initiative aims to improve the independence and quality of science reporting. Of note, their mentoring program includes editorial internships at leading media organisations.

Such a training program in Australia would obviously help build the pool of expert science journalists and I think Australia should support a similar program. The Government is drawing up a new National Science

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Amazing science array at Melbourne Youth ANZAAS

the last of the biology-related visits before moving across to the university one last time to complete the remaining serious work of the week in the chemistry department, where some final practical work was in store and CSIRO arrived to talk about designer chemistry.

The final night dinner was a spectacular affair at the 'Fish Bowl' of the Melbourne Aquarium where our student participants were hosts to about 30 guests. Paul Willis of the ABC's *Catalyst* program was MC for the evening and three eminent speakers presented aspects of the ultimate extension of evolution entitled, 'Big Bang to Bust'.

ANZAAS gratefully wishes to acknowledge its sponsors for this event – the Federal Department of Innovation, Industry, Science and Research, the Victorian Department of Education and Early Childhood Development and the National Academies Forum. ◀

Youth ANZAAS brings together school students in years 10, 11 and 12 from Australia and New Zealand with special interests in science. The annual event, now in its 63rd year, rotates around capital cities. Last year it took place in Dunedin and in 2007 in Perth. Next year Sydney will be the host city and in 2011 it will be Brisbane.

DR MIKE MURRAY joined CSIRO in 1975. He was Chief of the CSIRO Division of Materials Science and Technology from 1987–97 and CSIRO Corporate Executive from 1997–01. He was a founder of Ceramic Fuel Cells Ltd in 1992, and X-Ray Technologies Pty Ltd in 1997. In 1997 he founded and Chaired the Industrial Synchrotron Roundtable, the body which laid the necessary science/business foundation to build a synchrotron in Australia. He is Chairman of Celvis Ltd, Director (formerly Chairman) of Bluechip Pty Ltd, Principal of Brightside Pty Ltd and Chairman of the Council of ANZAAS.

Communication Strategy. I recommend inclusion of a science journalism internship training program in that new strategy.

One thing that distinguishes science journalism from general journalism is its fundamentally international flavour. News editors can exploit that fact to their advantage.

Cosmos is produced and distributed locally. In contrast, our *Cosmos* website is open to the world. Our online stories attract a large number of international readers. Whether it is medical advances, new energy technologies or astronomical discoveries, science stories attract readers, and their interest has a global flavour.

What else can we do to assist science journalism? We can learn from the STELR project. One of the key things we do in STELR is to provide each teacher with curriculum material that makes his or her job easier – but not shallower.

A journalism analogy would be a national science newswire, modelled on Reuters or Associated Press, to address the problem that sourcing stories is a constant and expensive challenge, and that the number of journalists specialising in science is small. A national science newswire would be run by journalists and operate on normal editorial principles. With reporters in every state, a national science newswire would add local science and technology stories to the international coverage already provided by existing newswires.

To make this a reality, as part of its emerging National Science Communication Strategy, the Government should consider establishing a national science newswire, which would be complementary to the Science Media Centre that

was established in 2005 to provide clarity to the debate on major scientific issues and is doing an excellent job.

A billion new skilled jobs globally

In a ministerial report published this year in the UK it was stated that “over the next 20 years up to a billion new skilled jobs globally will be created in science, technology, engineering and maths”. A lot of those jobs will need to be created in Australia. To meet this demand, we must find and inspire the next generation of scientists. If young people are not inspired to choose a career in science, at the very least I hope that through our efforts to cultivate their science education they will develop an appreciation for science and evidence-based thinking.

The more that people understand science, the better they will be able to participate in the complex technical debates of our times. Programs such as STELR, the Rio Tinto Big Science Competition and many more can help achieve this, but they must be coupled with clear government strategies in national curriculum development and assessment and facilities.

The late astronomer and author Carl Sagan said: “We have designed our civilisation based on science and technology, and at the same time arranged things so that almost no one understands anything at all about science and technology. This is a clear prescription for disaster.”

It's up to us. We must help young people recognise the relevance of science in their lives and the rewards they will reap from choosing a career in science. Their future, and ours, depends on it. ◀

Government announces \$2 million for STELR

Education Minister Julia Gillard has confirmed the Government's support for the STELR program, describing it as an innovative new school science education initiative to encourage more students to study science.

Ms Gillard announced that the Government had committed \$2 million towards the roll out of the Science and Technology Education Leveraging Relevance (STELR) program to about 180 secondary schools next year. The announcement noted that the STELR project, designed by ATSE, aimed to increase participation in science-related careers by getting Year 9 and 10 students excited about science.

“STELR focuses on the topic of renewable

energy and takes a hands-on, inquiry approach to the teaching of science,” the Minister said. “Teachers will be provided with the professional development and curriculum materials required to ensure a stimulating learning environment for their students.”

Ms Gillard said that the Government recognised that high quality science education was critical for building a strong, prosperous and innovative society.

“As part of its Education Revolution, the Government is investing in a range of initiatives to invigorate science education in schools and increase the number of specialist science teachers.

“The first phase of the development of

the new National Curriculum for all students from Kindergarten to Year 12, which includes science, is well under way.

“STELR will align with and support the national science curriculum and complement the investment already made by the Government to revitalise science education in Australian schools.

“Science graduates who go on to work in related occupations, including teaching, are now eligible for a refund of around half on their HECS-HELP repayments for up to five years,” she added.

“It is vital more students go on to study science and maths after school, so Australia can meet the demand for these skills, which are critical to Australia's future.”

Only a price on water can end threat to food security

Water scarcity already undermines food security in China, India, Pakistan, most of North Africa and the Middle East, and large parts of southern Africa



By Colin Chartres

c.chartres@cgiar.org

As the world awakens to the harsh realities of climate change and food insecurity, much of it apparently remains oblivious to a looming global water crisis, which climate change will aggravate by making rainfall more erratic in many regions.

Australia has already gone a long way down the reform path and has much to teach the world in terms of modernising irrigation, efficient and productive on-farm water use and in improving governance arrangements for water. It's time for world leaders to face the facts and embrace major reforms in water use, as called for by experts who attended World Water Week in Stockholm recently.

Within 40 years, the world will have an additional 2.5 billion mouths to feed, most of them in developing countries. This reflects an expected doubling of Africa's population and a 27 per cent increase in Asia, with far more dramatic growth in some countries, like Pakistan, whose population will jump by 85 per cent.

If we continue with current trends which have wealthier populations eating more livestock products (dairy and meat) and existing food losses between field and fork, global crop production will have to double to feed the growing population. Many farming experts believe this is technically feasible – with or without genetically modified crops.

But to deliver on the promise of science, the agriculture of tomorrow will need a lot more water. Given that one litre (more for livestock products) is used to produce one calorie of food and taking food losses into account, it will take up to 6000 cubic kilometres of additional water annually to feed another 2.5 billion people 2500 calories per day. This is almost twice what we use today and is not sustainable.

It is not at all clear where this water will come from. Agriculture is already the global economy's thirstiest sector, accounting for 70 to 80 per cent of total water use. Yet, by 2050, its share will have declined to about 60 or 70 per cent, as a result of competing water demands on multiple fronts, such as urban expansion and industrial development.

In the face of worsening water scarcity in agriculture,

the steady demise of Asia's regulated irrigation systems using surface water is especially worrisome. Built on a vast scale throughout East, Central and South Asia in the 1970s and 1980s, these systems have since suffered neglect and are no longer adequate. They are rapidly being supplanted by anarchic water scavenging, based on the use of inexpensive pumps for irrigation, mainly using groundwater. Governments' inability to regulate this practice is giving rise to scary scenarios of groundwater exhaustion, which could lead to regional food crises and widespread social unrest.

A roll call of countries where water scarcity already undermines food security includes China, India, Pakistan, most of North Africa and the Middle East, and large parts of southern Africa. In the coming decades, as countries struggle to feed their growing populations, many will have to import large amounts of food, putting a major drain on their economies.

About one-third of the world's population already live in areas where water is physically scarce, or economically scarce due to limited investment in necessary water delivery infrastructure. This figure will rise significantly by 2050.

There is a way out of this predicament for water-scarce countries, but it will involve thorough policy reforms and major new investments. Though hardly as simple as just adding water, the recipe for success is fairly straightforward.

A critical first step is to create fair and effective policies for allocating water, as competing demands increase. This, in turn, requires a clearer definition of water rights and better measurement and modelling of water availability.

As governments adopt such policies, their historic tendency to focus mainly on water supplies for drinking and sanitation – to the neglect of water for agriculture – must come to an end. This doesn't mean people should be deprived of their basic human right to clean water. The point is that the amount of water needed for drinking and sanitation amounts to only about 10 per cent of total water use. The rest goes to a wide variety of equally beneficial uses, the biggest of which is agriculture.

Thus, the central challenge for governments is to make

agricultural use of water more productive and efficient. Two ways of doing this are to refurbish irrigation systems and improve rain-fed agriculture through better soil management and expanded use of water harvesting and supplemental irrigation. New crop varieties that tolerate extreme conditions, like drought and flooding, can also help.

The hard part in the developing world is creating incentives for governments to implement reforms. Current governance arrangements were generally designed around the middle of the last century, based on colonial models, in which water was viewed as an unlimited free good.

Though now absurdly inappropriate, these models are kept in place by strong vested interests. The water and agricultural sectors are permeated from top to bottom by fear of the political repercussions that reforms in water governance might bring.

Governments must now set aside those fears and adopt a new paradigm under which water is valued and ultimately priced. In other words, societies must start to pay for the environmental and other benefits that water brings. Only then can they avert the water crisis and ensure future food security. ◀

DR COLIN CHARTRES has 30 years' experience in driving research and policy reform in natural resource management, with a focus on water and soils, both in Australia and overseas. He is Director-General of the Sri Lanka-based International Water Management Institute (IWMI) and has spent a considerable part of his career working on international development issues with organisations such as CSIRO, AusAID, the Australian Geological Survey Organisation and the Bureau of Rural Sciences. Prior to his IWMI appointment he was Chief Science Adviser to Australia's National Water Commission.

Australia world leader in urban water efficiency

Adapting to climate change is the main driver of \$14 billion in urban water industry infrastructure projects now under way to develop new sources of water, upgrade wastewater systems and cater for burgeoning urban population growth, the annual Water Report Card shows.

Released by the Water Services Association of Australia (WSAA), the report card outlines the \$30 billion investment in a portfolio of new water sources which commenced in 2006 and will conclude in 2013 when Adelaide and Melbourne's desalination plants begin operation.

This massive investment coupled with community awareness of water efficiency, has set Australia at the international forefront in managing urban water systems.

Much capital expenditure relates to developing new water sources to mitigate risks associated with climate change and to

cut reliance on rainfall run-off, said WSAA executive director Ross Young.

"Relying on rainfall is a high-risk strategy in an era of climate change," Mr Young said, noting that capital city residential water consumption continues to fall.

"The extent to which water efficiency has been embraced by urban communities is one of the great social changes that have occurred in Australia over the past decade.

"Had consumption held at 2002-03 levels, a further 210 gigalitres – equal to the annual Melbourne household water use – would have been consumed in 2007-08."

"Australia leads the world in implementing water-efficiency programs in cities and towns."

Mr Young said the Australian community had responded by embracing and developing a very strong water-conservation ethos that grew as the spectre of climate change turned into a harsh reality.

Nanotubes speed desalination

A team of researchers from ANU has discovered a way to remove salt from seawater using nanotubes made from boron and nitrogen atoms that will make the process up to five times faster.

With population growth and climate change limiting the world's fresh water stores, desalination and demineralisation are gaining traction, but there is an urgent need to make the process of desalination more effective and less costly than current methods.

The ANU team used computational tools to simulate the water and salt moving through the nanotube. They found that the boron nitride nanotubes not only eliminated salt but also allowed water to flow through extraordinarily quickly, comparable to biological water channels naturally found in the body.

Work is continuing to further investigate these possibilities and the team anticipates such devices, successfully manufactured, could be used for antibiotics, ultra-sensitive detectors or anti-cancer drugs.

\$20 million for Brisbane Water Recycling Centre

Western Corridor Recycled Water Pty Ltd will receive \$20 million in federal funding over five years to host the National Centre of Excellence in Water Recycling in Brisbane. Western Corridor Recycled Water – owned by state authority WaterSecure – will host the centre with involvement from founding partners the University of Queensland, Griffith University, the University of NSW and CSIRO, along with industry partners including Veolia Water Australia Pty Ltd and GHD Pty Ltd. The centre is expected to start work later this year.

WaterSecure CEO Keith Davies said the expertise of the centre's partners and connections with national and international academia, industry and technological providers would ensure that Australia was recognised as an international leader in water recycling research.

Doug Medwell
(left) receives
his award from
SA Division
Secretary/
Treasurer
Dr Peter
Coldrey.



SA Teacher Award marks outstanding achievement

Doug Medwell's "outstanding achievement" as a physics teacher has won him the ATSE SA Division's 2009 annual award for excellence in the teaching of science, technology, engineering and mathematics (STEM) subjects in South Australian secondary schools. The award recognises both the teacher and the school that supports him/her in this endeavour.

The 2009 award, in the form of a trophy and framed certificate for the teacher and a perpetual plaque and a cheque for \$2000 for the school, was presented to Mr Medwell and his principal – Associate Professor Jim Davies, principal of the Australian Science and Mathematics School (ASMS), which is closely associated with Flinders University.

The presentation was made at the SA Science and Engineering Super Challenge held at the Adelaide Super-Drome in August.

The award recognised Mr Medwell's outstanding performance as the leading teacher of physics at ASMS, characterised in the award citation:

"Doug excites students' interest for physics and technology through his passion for his subject combined with the use of effective teaching methodologies that enhance opportunities for all students to meet with

success in achieving learning outcomes.

"He has successfully implemented a broad range of learning activities for students in an ICT-rich environment that engages, challenges and motivates them to high achievement. Doug has also shown leadership and creativity in working with staff teams in preparation of multidisciplinary curricula and to ensure that the rigour of the physics discipline is maintained within the interdisciplinary framework.

"His leadership in the development of learning sequences in astrophysics and nanotechnology are good examples of his outstanding achievement."

ATSE SA Division was a sponsor of this year's SA Challenge and Super Challenge events, which saw 75 teams of more than 2000 students in Years 9 and 10 competing over 10 days in Adelaide, Mount Gambier and Port Pirie. Winning teams from Temple Christian College and Faith Lutheran College will go on to compete in the national Grand Challenge finals in Bendigo in October.

Max Lay's *Handbook of Road Technology* reprinted

Taylor and Francis has just published the fourth edition of Dr Max Lay's book, *Handbook of Road Technology*, under its Spon imprint. The

944-page hardback book – in the words of the publisher – continues to be an indispensable international resource for students and professionals in transport planning, engineering, operations and economics.

"This fully revised fourth edition of Max Lay's well-established reference work covers all aspects of the technology of roads and road transport. It forms a comprehensive but accessible reference for all professionals and students interested in roads, road transport and the wide range of disciplines involved with roads," Taylor and Francis says.

"International in scope, it embraces all aspects of urban and rural road technology, drawing on the author's many decades of consulting and operational experience in the financing, planning, design, construction, operation and management of roads in various countries, and is built on a sound theoretical basis.

"The book begins with coverage of the important procedures involved in the construction of roads, from road planning policies and design considerations to the selection of materials and the building of roads and bridges. It then offers insights into road operating environments that include driver behaviour, traffic flow, lighting and maintenance, and assesses the cost, economics, transport implications and environmental impact of road use.

"Presenting the latest actively-used technology, the *Handbook of Road Technology* continues to be an indispensable international resource for students and professionals in transport planning, engineering, operations and economics."

Handbook of Road Technology can be ordered for \$265 from www.eabooks.com.au.



Max Lay

Fellows Prominent in 2009 Top 100 Engineers listing



Mary O'Kane



Alex Zelinsky

More than 30 per cent of Australia's "most influential" engineers are Fellows of ATSE, according to Engineers Australia's 2009 Top 100 Engineers listing.

Published in *EA Magazine*, the Top 100 lists engineers in seven categories – Industry, Consulting, Academia/Research, Engineering Expertise, Associations, Public Service and Politics/Other.

ATSE Fellows made up 31 of the names in the 2009 Top 100 Engineers list, the sixth year it has been organised by Engineers Australia. Fellows also comprised four of the six selection advisory panel members – ATSE Vice-President Dr John Nutt AM FTSE, General Peter Gratian AC OBE FTSE, Mr Peter North AM FTSE and Dr Mike Sargent AM FTSE.

ATSE Fellows contributed 13 names to the list of 44 comprising the biggest category (Industry). Mr Leigh Clifford AO FTSE (Chairman, Qantas), Dr Peter Farrell AM FTSE (Chairman and CEO, Resmed), Mr James Graham FTSE (MD, Gresham Partners), Mr John Grill FTSE (CEO, Worley Parsons), Mr Gordon Jardine FTSE (CEO, Powerlink Queensland), Dr Wal King AO FTSE (CEO, Leighton Holdings), Mr Andrew Michelmore FTSE (CEO OZ Minerals), Mr Douglas Rathbone AM FTSE (CEO Nufarm), Dr Chris Roberts FTSE (CEO, Cochlear) and Dr John Schubert FTSE (CEO, Commonwealth Bank) all made repeat appearances. First-timers were Dr Bob Every FTSE (Chairman, Wesfarmers), Dr Andrew Liveris FTSE (Chair, President and CEO, Dow Chemical) and

Mr Don Voelte FTSE (MD, Woodside).

ATSE dominated the Academia/Research listing, providing 11 in an expanded category of 16 names – Professor Peter Dowd FTSE (President, Australian Council of engineering Deans), Professor Mike Dureau FTSE (Chairman, Warren Centre for Advanced Engineering), Dr Alan Finkel AM FTSE (Chancellor, Monash University), Professor Paul Greenfield AO FTSE (VC, University of Queensland), Professor Greg Hancock AM FTSE (Dean, Engineering and IT, University of Sydney), Professor Archie Johnston FTSE (Dean of Engineering and IT, UTS), Professor Bev Ronalds FTSE (Group Executive, Energy, and Chief, CSIRO Petroleum), Dr David Skellern FTSE (CEO, NICTA), Professor Geoff Stevens FTSE (Pro Vice Chancellor, University of Melbourne), Professor Ian Young FTSE (Vice Chancellor and President, Swinburne University) and Professor Alex Zelinsky FTSE (Group Executive, Information and Communication



Bev Ronalds

Sciences and Technologies, CSIRO).

In the Consulting listing, ATSE contributed two names – Mr Paul Douglas FTSE (CEO, Sinclair Knight Merz) and Dr Robert Care FTSE (Chair, Arup Australia) both listed again.

Surprisingly, ATSE did not have a Fellow listed in the Engineering Expertise category, which it dominated the previous year.

ATSE President Professor Robin Batterham AO FREng FAA FTSE was listed in the Associations category, Dr Stephen Gumley FTSE (CEO, Defence Materiel Organisation) and Dr Menno Hennevel FTSE (Commissioner of Main Roads, WA) were named in the Public Service category and WA Governor Dr Ken Michael AC FTSE and Dr Mary O'Kane FTSE (NSW Chief Scientist and Scientific Engineer) were listed in the Politics/Other category.

Pioneer WA Fellow dies

ATSE notes with sadness the passing of its Fellow, Emeritus Professor Jack Loneragan AM FTSE in Perth on 11 August, following surgery, aged 83.

Professor Loneragan, a Fellow for more than 30 years (since 1977), spent 17 years at Murdoch University from 1973, achieving the position of Professor of Biology and Pro Vice-Chancellor (Research) at Murdoch University. He was Acting Vice-Chancellor 1989-90, before his retirement. He was also Western Australian Coordinator of the Crawford Fund from 1995 to 2000.

He took his PhD at the University of California (Berkeley) in 1953 then spent 20 years at CSIRO and the University of WA, where he became Dean of Agriculture. He was awarded the Medal of the Australian Institute of Agricultural Science in 1985 and was appointed Member of the Order of Australia in 1991.

He was a Fellow of the Australian Institute of Biology, the Australian Institute of Agricultural Science and the Institute of Biology (UK).

He was President of the Royal Society of Western Australia (1981-82) and a Member of the International Council of Plant Nutrition, serving as its President 1989-93.

Interviews capture three Fellows



Bruce Holloway

The Academy of Science honours leading Australian scientists in its 'Interviews with Australian Scientists' project. On its website you can find interviews with some of Australia's leading scientists and discover how they change the world we live in.

The latest posting includes three prominent ATSE Fellows – geneticist Professor Bruce Holloway, chemist Professor Ray Martin and chemist Professor John Swan – detailing their lives and work. The site also previews a further interview with a fourth ATSE Fellow, geologist Mr Roy Woodall.

Professor Bruce Holloway AO FAA FTSE enjoyed performing biological experiments as a young boy, even before he knew this was what he was doing. His inquisitive nature led him into a long and distinguished career as a geneticist. Chief among many positions he has held, Professor Holloway was appointed foundation professor and department head of genetics at Monash University in 1968. He served the university in these dual roles for 25 years. Professor Holloway was elected to the ATSE Fellowship in 1990 and is a former

Director of the Master Class Program for the Crawford Fund.

Professor Ray Martin AO FAA FTSE had a strong family background in science and his interest in it was innate from an early age. He

decided that one physicist in the family was enough, so he started on a long and prosperous career path as an inorganic chemist. During his career in chemistry he was a foundation professor of inorganic chemistry at the Australian National University and Vice-Chancellor of Monash University. He joined ATSE in 1989 and was Chairman of the symposium Organising Committee 1992-96.

Professor John Swan AO FAA FTSE has had a wonderfully diverse career in chemistry, from researching wool protein to contributing to the synthesis of the peptide hormone, oxytocin.

Professor Swan spent nearly 20 years at Monash University

where he served as professor of

organic chemistry, Pro Vice-Chancellor of the university and dean of the Faculty of Science. Professor Swan has also served for many years as a champion for the preservation of marine environments around Victoria. He joined ATSE in 1994

The Academy of Science established the Interviews with Australian Scientists program in 1993 to record interviews with outstanding Australian scientists. The scientists talk about their early life, development of interest in science, mentors, research work and other aspects of their careers.

The interviews with the ATSE Fellows are at www.science.org.au/scientists/index.htm.

President to address National Press Club

ATSE President Professor Robin Batterham will speak at the National Press Club in Canberra in a nationally televised address on 4 November.

The title for his address is 'Are we leaving climate change to the next generation and does it matter? Exploring the realities of

renewables, nuclear, geothermal, super smart grids and the like.' The synopsis for his address outlines a topic that should draw a keen audience of journalists, commentators and Canberra figures.

"When we turn to the scientists we get a range of opinions on what must be done in the near future in terms of climate change," Professor Batterham says. "The range seems more about their belief systems than their science, with the sceptics at one end and the modellers at the other.

"As a past Chief Scientist, but trained as an Engineer, I look to my colleagues and hear language which is more about risk and the management of risk. Australia is one of the few food bowls of the world, as well as a supplier of key energy and raw materials. How do we go for the options that might make sense economically and enhance our resilience to cope with the future?

"Changing our mix of technologies, even to those that are supposedly well established, takes time, effort and money. There is great agreement that the expected price on carbon is not going to be enough to drag through significant technological changes. We are not going to see widespread geothermal, nuclear, all-electric vehicles, hybrid locomotives, super smart grids or large-scale use of biofuels in under 20 to 30 years.

"Does this matter? The answer is probably yes, and on a risk-reduction basis we just might have to get our minds around picking a few winners."

Chinese scientists visit Australia

Eight mid-career Chinese scientists from the fields of energy and biotechnology, including biomedical technology and nanotechnology, participated in a 10-day exchange visit to Australia on 17 to 28 August as part of the Australia-China Young Scientist Exchange Program.

The Academy thanks ATSE Fellows and their colleagues who arranged an exciting program of targeted visits to leading Australian universities, CSIRO, CRCs and industry.



Ray Martin



John Swan

Connecting Australia and Korea through our young scientists

ATSE and the Academy of Science, along with the Australian Korean Foundation, have just hosted four early career researchers from the Republic of Korea for a two-month research placement in Australia under the guidance of Australian hosts

Towards the end of their visit, their senior Korean mentors, each with a good knowledge of the research interests of the young scientists, came to Australia for a week, to oversee the young scientists' research project, engage with their hosts and meet with leading Australian S&T colleagues. The exchange scheme finished with a half-day debriefing session in August, where the early career researchers presented on their experiences in Australia and possible collaborative projects.

ATSE is grateful to the Australian hosts and Professor Mike Miller AO FTSE for their valuable support with these placements. The Australian hosts were:

- Professor Jiyuan Tu, School of Aerospace, Mechanical and Manufacturing Engineering, RMIT University;
- Professor Andy Tan, Department of Mechanical Engineering, QUT;
- Professor Peter Raisbeck, Department of Architecture, Building and Planning, University of Melbourne; and
- Dr John Olsen, School of Mechanical and Manufacturing Engineering, UNSW.

Fellow to chair international GM conference

Professor German Spangenberg FTSE, Executive Director of the Bioscience Research Division, Victorian Department of Primary Industries, will chair the 2009 GM Crops Coexistence Conference (GMCC'09) in Melbourne, 10 to 12 November 2009. The

conference is the only international forum focused on the coexistence of GM and non-GM agricultural supply chains and this will be the first time it has been held outside Europe.

GMCC'09 will cover key issues on coexistence between GM and non-GM agricultural supply chains including:

- gene flow in agricultural systems;
- coexistence strategies and organisational measures across the supply chain;
- socioeconomics of coexistence and cost/benefit analysis of coexistence strategies;
- legal and policy issues of coexistence frameworks; and
- traceability and control of coexistence.

The conference will highlight the progress of the Australian approach to coexistence between GM/non-GM canola.

Mark Tweeddale led risk engineering

The Academy notes with sadness the death of Dr Mark Tweeddale FTSE, a former ANSTO Professor of Risk Engineering at Sydney University and Executive Director of the Australian Centre of Advanced Risk and Reliability Engineering, who died in Sydney on 15 August, aged 71, after a prolonged illness.

A Fellow since 1995, Dr Tweeddale spent 24 years, to 1987, with ICI Australia in Melbourne, Sydney and London before taking up his professorship from 1988 to 1996. He was a former member of the NSW Division Committee.

He was active in Academy affairs in NSW, organising a number of events including a seminal symposium on 'Risk in Society' in 2002.

After schooling at Scotch College, Melbourne – where he came second in the state in physics in the Year 12 external examinations – he graduated from the University of Melbourne with a BE in Electrical

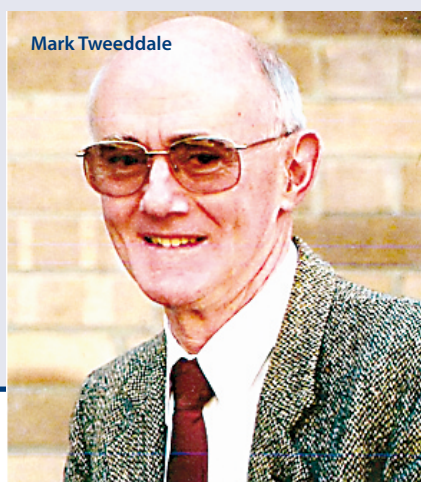
Engineering. This was followed by a long and distinguished career in industry and academia. In 1999 he submitted his published papers to his alma mater and was awarded a Doctor of Engineering. Upon graduation he went to Manchester on a three-year postgraduate scholarship and on returning to Australia in 1963, he joined ICI Australia.

He became interested in risk and reliability analysis when he was appointed corporate project safety manager with responsibility for plant safety design in all the large new plants ICI was constructing throughout Australia. At that time, ICI in the UK was the world leader in the field, and he developed special skills which were to be the focus of his life's work. Upon successful completion of the Australian plant expansions, he was transferred to England as the company's hazard and risk technical adviser and for two years in 1984 and 1985, he visited, surveyed and advised on numerous process plants of world scale operated by ICI and other companies in the UK, Europe and South America.

After his return to Australia, he was appointed, in 1988, to the foundation ANSTO Chair of Risk Engineering in the Department of Chemical Engineering at Sydney University, and provided advice to industry as Executive Director of the Australian Centre for Advanced Risk and Reliability Engineering (ACARRE), a risk engineering consulting organisation, on behalf of both the university and ANSTO. When the initial three-year term expired, he accepted a five-year extension.

He started his own consultancy on leaving the university in 1996, but continued to lecture part time for three more years until a successor was found to take over the subjects he had developed from scratch. He gave a risk course to the university of Western Australia and continued to do so until 2005. Meanwhile, he distilled his experience into a book, *Managing Risk and Reliability of Process Plants*, which was published in the US by an arm of Elsevier Publishers in June 2003, and which has since been reprinted.

Dr Tweeddale was awarded the Centenary Medal for services to engineering. • Edited from a contribution by Dr Ian Sare FTSE and Dr John Nutt AM FTSE.



Mark Tweeddale



Peter Joubert buckles up in a 1960 Volvo.

Peter Joubert helps mark 50 years of seatbelts

Professor Peter Joubert, a Fellow since 1979, was featured in *The Age* newspaper in Melbourne in August helping celebrate the 50th introduction of the introduction of three-point car seatbelts to Australia.

Professor Joubert, a campaigner in the 1960s for the introduction of the mandatory wearing of seatbelts, was pictured 'buckling up' in a 1960 Volvo, one of the first models in Australia to have the three-point belts.

Invented by Volvo engineer Nils Bohlin in 1959, Volvo's open patent granted free use of the design for the life-saving V-shaped three-point seatbelt to all other car manufacturers.

Today, the simple 'click-clack front-and-back' has been recognised worldwide as the most widely used and significant safety innovation in the automobile's more than 120-year history. It is estimated that more than a million people owe their lives to the seatbelt, and it has saved many times that number of people from serious injury. It is also recognised as one of the eight patents to have the greatest significance for humanity during the hundred years from 1885 to 1985.

The real breakthrough in legislation came from Victoria, which was the first state in the world to draw up legislation in 1970 requiring not just the fitting of seatbelts, but also their actual use. In the first year of law, traffic fatalities in the state dropped by 18 per cent. NSW followed with similar

legislation a year later and today, everyone but taxi drivers are legally required across Australia to wear seatbelts front and back.

Australia and Japan target emerging research leaders

Australia and Japan have launched a new joint program to optimise the skills of leading mid-career researchers through an exchange of emerging leaders in science and technology.

The Australia-Japan Emerging Research Leaders Program (ERLP), starting in 2010, will enable mid-career researchers to undertake two weeks of institutional placements in agreed priority science and technology areas.

This important opportunity is being funded in Australia by the Australian Government's Department of Innovation, Industry, Science and Research (DIISR). ATSE will operate the program for DIISR, with the Japanese funding and organisation coming from the Japan Society for the Promotion of Science (JSPS) in cooperation with the Engineering Academy of Japan (EAJ).

The program recognises the long-established science and technology links between Australia and Japan and will give participants access to leading experts from the partner country. ATSE expects the program will contribute to the continued advancement of science, technology and economic

development between Japan and Australia through enhanced technological exchange and institutional links, leading to possible joint research projects and seminars.

Australia and Japan will exchange mid-career researchers on a reciprocal basis in early 2010. Each visit will be about two weeks, starting with an orientation session, followed by placements in various research institutions and ending with a debriefing session in which participants will outline paths for further linkage within the host country.

The topics for the 2009-10 exchange will focus on energy and environment; novel materials and resources; and biotechnology and its medical applications.

Fellows deliver major Canberra addresses

Two ATSE Fellows delivered addresses to Academy of Science audiences in Canberra in August.

Dr John Wright FTSE, with 35 years' experience in the minerals and energy sector, discussed Australia's renewable energy future in a public lecture titled 'The contribution of renewables in Australia's future energy mix'. Dr Wright is an adviser to CSIRO's Sustainable Energy Partnerships, working across CSIRO to develop major partnerships with industry, governments and the community. He was previously the Director of the CSIRO Energy Transformed Flagship, from 2002-08. His lecture considered the mix of technologies we need to have to achieve various cost, reliability and environmental objectives and the role of renewables in meeting these objectives to 2050.

Dr Michael Raupach FAA FTSE, from CSIRO Marine and Atmospheric Research, delivered a public lecture 'Climate change, human aspiration and the finite capacity of planet Earth'. From 2000 to 2008 Dr Raupach was an inaugural co-chair of the Global Carbon Project of the Earth System Science Partnership. His research encompasses global and continental carbon and water cycles, carbon-climate-human interactions, land-air interactions, fluid mechanics and particle transport. He is a frequent contributor to the policy and public debate on climate change.

Sam Samuels: one of our best-known metallurgists

Dr Leonard (Sam) Samuels AM FTSE, a Fellow since 1981 and a former Director of the Defence Science and Technology Organisation (DSTO) Materials Research Laboratories, has died aged 87. The Academy notes his passing with regret.

Dr Samuels, a metallurgist who produced 80 scientific publications and four books, was also a Fellow of Engineers Australia and a Member of the Institute of Metals and Materials, Australasia, and International Metallographic Society.

Fellow Ian Polmear AO FTSE contributed this obituary:

Sam Samuels enrolled in metallurgical engineering at the University of Melbourne in 1939 and graduated in 1942 – working part-time with the Munitions Supply Laboratories at Maribyrnong during the final year of his course and later joining the staff.

In 1943 he was transferred to the small Sydney Branch of MSL at Alexandria, where he became Officer in Charge. MSL was one of several government laboratories involved in metallurgical activities that supported the wartime production of armaments and which, in the late 1940s, turned their attention to longer-term research programs.

This was the beginning of what Sam used to call 'the golden years' for research in Australia – two or three decades when much freedom was allowed for staff to pursue their own ideas and interests. Rigid timetables involving the achievement of 'milestones' and 'outcomes' were much less evident. In Sam's case, he expanded his interests in metallography.

He had a passion for peering down microscopes. What the viewer sees depends upon how carefully the metal surface has been polished beforehand, which was then often a slow and tedious process. Sam sought to put surface preparation on a more scientific basis and later published a book on mechanical polishing of metals that ran to four editions.

By this time his research had attracted international attention and in 1957 he was awarded the prestigious David Syme Research Prize and the following year the University of Melbourne

conferred the degree of Doctor of Science for an external thesis based on his published works.

After 20 years in Sydney, Sam was transferred back to Melbourne to take up the position of Superintendent of the large Metallurgy Division at the renamed Defence Standards Laboratories at Maribyrnong. He gave his attention to reviewing and strengthening the divisional research programs while pursuing his own personal research interests, expanding his research to include general studies of the mechanisms of surface abrasion and wear of metals.

In 1980 he received the Sorby Award from the International Metallographic Society.

During the 1960s and 1970s, metals and other materials had become the focus of much of the work at DSL, which was renamed the Materials Research Laboratories and served as part of the Defence Science and Technology Organisation.

Sam became Director of MRL in 1981 and took early retirement two years later, but his interest in metallography continued for another 20 years or so. He produced two more books that were commissioned and published by the American Society, ASM International. Light Microscopy of Plain Carbon Steels, which appeared in two editions, was illustrated by some 1200 photomicrographs that he and his former colleagues at MRL had prepared over many years.

Sam's external professional interests were centered mainly on the Australian Institute of Metals (now Materials Australia) – serving as President of the Sydney and Melbourne branches and later as Federal President. In an account of

the first 50 years of the institute, published in 1996, Sam was nominated as one of a small group of members who had made the greatest contributions to its operations over this period.

Water focus for WA Eminent Speaker

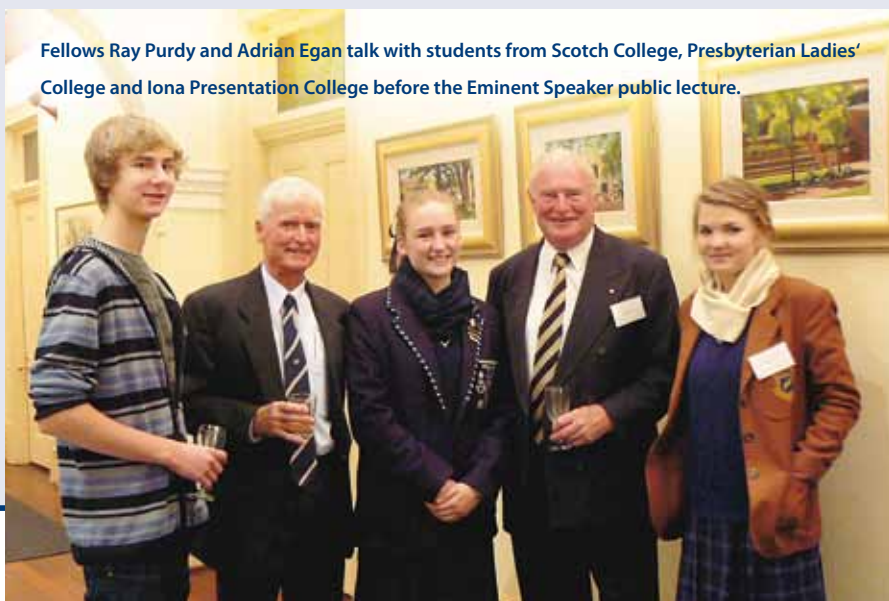
Professor Jorg Imberger AM FEng FAA FTSE, Director of the Centre for Water Research and Professor of Environmental Engineering at the University of Western Australia, was the 2009 Eminent Speaker for ATSE's WA Divisions.

He addressed 430 students from 11 high schools at Curtin University on 5 August and 170 from five high schools at Edith Cowan University on 7 August on the topic 'Water resource challenges for WA: more rain, but in the wrong place'.

He also presented an evening public lecture 'Real time, self learning adaptive river basin living' at Presbyterian Ladies' College on 7 August, which attracted 180 members of the public, students and ATSE Fellows. This talk described how improvements in sensor technology and modelling already allow operational control of water quality and will in future affect many aspects of our lives. Professor Imberger explained how the technology can be applied to the Swan–Canning River system, and the evolution of dynamic websites that allow for community involvement in accumulation of data necessary for management decisions.

The Eminent Speaker event is sponsored by SciTech, Presbyterian Ladies' College and the WA Science Teachers Association. The talks can be viewed online at www.cwr.uwa.edu.au/presentations.php?category=6.

Fellows Ray Purdy and Adrian Egan talk with students from Scotch College, Presbyterian Ladies' College and Iona Presentation College before the Eminent Speaker public lecture.



Fellows in the news



Hugh Bradlow

Hugh Bradlow

The telecommunications industry's top honour for individual achievement – the Telecommunications Ambassador Award – has this year been shared by Hugh Bradlow FTSE, Telstra's Chief Technology Officer, and Bevan Slattery of Pipe Networks.

Dr Bradlow, a Fellow since 1991, is recognised as both a technologist and a futurist, having being involved in the establishment of what is now a recognised centre of research excellence at the University of Wollongong. These and other winners of the 2009 Communications Alliance & CommsDay Awards were announced at the Annual ACOMM Awards Dinner. Communications Alliance CEO Anne Hurley said the high calibre of entries reflected the increasing maturity of the industry.

Terry Cutler

Dr Terry Cutler FTSE has been re-appointed to the CSIRO Board for a further three years. Other ATSE Fellows on the Board are Dr John Stocker AO FTSE (Chair), Dr Megan Clark FTSE (Chief Executive), the Hon. John Kerin AM FTSE, Mr Doug Rathbone AM FTSE and Professor Tom Spurling FTSE.

John Grace

Mr John Grace FTSE, ATSE Vice-President, is the new chairman of the University of South Australia's commercial arm, ITEK. Mr Grace brings extensive experience in the commercial development of leading-edge science, specifically biotechnology. He is currently director of iBIO Pty Ltd Consultancy and a member of the Council of the Australian Institute of Marine Science.

Min Gu

Swinburne researcher Professor Min Gu FAA FTSE has been appointed to the new

position of Pro Vice-Chancellor (International Research Collaboration) at Swinburne University of Technology. Professor Gu will be responsible for developing international research linkages with funding bodies, industry and research institutions, with a specific focus on Asia. He will also remain in his current position as director of Swinburne's Centre for Micro-Photonics.

Paul Haddad

Professor Paul Haddad FAA FTSE, ARC Federation Fellow and Director of the Pfizer Analytical Research Centre at the University of Tasmania, has been appointed to the ARC's Cluster One Research Evaluation Committee for the 2009 Excellence in Research for Australia (ERA) trial. He is one of 17 researchers appointed to the committee, which will cover the physical, chemical and earth sciences disciplines.



Paul Haddad

Rod Hill

Professor Rod Hill FTSE, Monash University's Pro Vice-Chancellor – Industry Engagement and Commercialisation, has been appointed to the Interim Advisory Board of the national \$20 million Enterprise Connect Clean Energy Innovation Centre, to be based in Newcastle. Enterprise Connect, through manufacturing centres or innovation centres, plans to provide practical advice and assistance to small to medium-sized enterprises by helping them acquire the knowledge, tools and expertise to improve productivity, increase competitiveness and fully capitalise on their growth potential.



Rod Hill

Brian McNamee

Government should not support R&D that competition would engender. Nor should it support R&D that capital markets would shun, says Dr Brian McNamee FTSE, CEO of CSL Ltd. It should support R&D that brings sustainable benefits to Australia and which,

without support, would not be done, would be insufficiently done, or would be done elsewhere, he says in the July issue of *Australian R&D Review*. The article can be viewed at www.arldr.com.au.

Mike Sargent

Dr Mike Sargent has been appointed to the Board of the new Australian Solar Institute. The ASI is a \$100 million commitment by the Australian Government to support solar thermal and solar photovoltaic research and development, aimed at fostering greater collaboration between solar researchers in universities, research institutions and industry and helping forge strong links with peak overseas solar research organisations. The ASI is part of the \$4.5 billion Clean Energy Initiative announced in the 2009 Budget.

Grant Steven

Emeritus Professor Grant Steven FTSE has been appointed to the Australian Research Council College of Experts on the Engineering and Environment Panel for three years. Professor Steven works and has been appointed as an 'end user' of research.



Grant Steven

Keeva Vozoff

Dr Keeva Vozoff FTSE has been honoured with the Reginald Fessen Award by the Society of Exploration Geologists, the US-based international society of applied geophysics. His award will be formalised at the SEG annual meeting in Houston in October. Dr Vozoff has been a Fellow since 1982.

Alex Zelinsky

Dr Alex Zelinsky FTSE, Director and Group Executive, CSIRO Information and Communications Technologies Centre, has been appointed to the Australian Government's new Information Technology Industry Innovation Council.

32ND ATSE NATIONAL SYMPOSIUM

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UQ DISCOVERIES IMPROVE DISEASE TREATMENTS

Researchers at The University of Queensland lead the way in immunology research.

Professor Ranjeny Thomas focuses on the study of the biology and clinical use of human dendritic cells in autoimmune disease. Her research has given rise to several clinical applications, including:

- antigen-specific vaccine to treat rheumatoid arthritis
- A therapeutic platform for antigen-specific immunotherapy
- A novel diagnostic test for identification of those at risk of 1 juvenile diabetes
- Novel immunothera

In February 2009, Professor Thomas and her team were awarded \$10.3m from the National Health and Medical

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