Australian Government

AUSTRALIA'S CHIEF SCIENTIST

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CHECK AGAINST DELIVERY

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Good morning

I am pleased to be invited to address you this morning.

It is important that we gather on occasions such as this, to acknowledge the achievements of our scientists and engineers, and I'd like to spend some time this morning doing that.

Today also presents an opportunity to reflect on whether we are adequately preparing ourselves to advance our nation into the future, to produce (if you like) the "engineering heritage of tomorrow" a topic I'd like to come back to later.

But first to the role science and engineering has played in Australia's development. (When I speak about this, I tend to use the term STEM – science, technology, engineering and mathematics. I find distinctions in this space diverting and unhelpful.)

STEM has provided the people and knowledge needed to make discoveries and deliver the innovation necessary to support Australia's economic and social advancement.

This happens within States, across the nation as well as beyond international borders.

When thinking about this kind of development, our natural inclination might be to focus on iconic infrastructure projects – like the Snowy Mountains Hydro-electric Scheme, located not too far from us here in Canberra.

These kind of major projects continue today and our engineering construction activity is expected to remain strong in the immediate future.

The total value of projects outstanding at the beginning of this year was more than $128 billion, an 11 fold increase on the value of projects a decade ago [1].

In fact Australia invests more in its infrastructure than almost every other major advanced economy, according to the Organisation for Economic Co-operation and Development (OECD).

Compared to the OECD average of 18.3 per cent of GDP, total public and private infrastructure spending in Australia stands at 26.5 per cent of GDP, second only to South Korea.[2]

These major projects and countless examples of improvements to products and processes stand as a legacy of scientific discovery and engineering application.

In fact it is hard to look at a breakdown of sectors within our economy and find one which does not rely, to some extent, on scientists and engineers.

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[1] Australian Bureau of Statistics, Cat No. 8762.0, *Engineering construction Activity*, Australia, December 2012 (released 03 April 2013); Austrade.

[2] Australian Engineering OnLine, *OECD Confirms Australia is a Big Investor in Infrastructure*, 24 March 2013. http://www.aeol.com.au/databases/news/oecd_confirms_big_investor.htm?zoom_highlight=economy

Agriculture, mining, manufacturing, utilities, construction, transport, media & telecommunications, and others – will continue to call on this expertise, as they have in the past.

Take for instance, the grand vision of the Goldfields Water Supply Scheme, completed in Western Australia in 1903[3], which continues to operate today, delivering water to more than 100,000 people.

Or on a smaller scale, the ingenuity of the Smith brothers in South Australia who invented the stump jump plough in the 1870s, allowing farmers to cultivate newly opened farming land in areas where obstructions in the soil meant traditional technology had failed.

Australian engineering has also had an impact on our more social pursuits.

The first automatic totalisator, which became better known as the “tote”, was designed by George Julius in 1913 and allowed horse racing odds and dividends to be calculated in a fraction of the time of the old, manual system.

In 1966 the portable, air-tight, wine container, which became better known as the “cask”, allowed large quantities of wine to be exported, and allowed Australians to keep 4 litre bags of wine that didn’t expire shortly after opening.

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[3] *The politics of the goldfields water supply scheme*, The National Trust of Australia (WA branch), The Golden Pipeline Resources and Activities, Pamphlet. Undated.

But it is through its capacity to contribute to increased productivity that engineering makes a significant contribution to our economy.

In industries like mining, innovation was once the domain of individuals like Kalgoorlie draftsman Charles Warman, who in 1938 developed slurry pumps to more effectively transport mixtures of ore and water.

Today it is teams like those from the Mining Cooperative Research Centre (CRC) that continue to seek ways to make the industry more efficient.

For two decades the CRC has - through engineering and scientific expertise and research - sought to provide the means to meet challenges in the sector, from productivity to specialist skill shortages to locating and extracting mineral deposits.

Earlier I mentioned that science and engineering had historically forged partnerships across borders, be they State or international.

The Mining CRC has researchers from the University of Queensland, the University of Newcastle, The University of Western Australia and Curtin University.

And it has fostered international collaboration as well – with researchers from Chile, South Africa and the US joining

Australian colleagues in work to improve industry profitability, productivity and safety.

It also supports collaboration between research and industry, to ensure their research meets the needs of industry partners, which currently include BHP Billiton, CSC Australia, XStrata Coal and Caterpillar Underground Mining.

Research projects have resulted in new mining methods, cutting-edge mining equipment and highly-skilled experts actively working in the global mining industry.

Another field in which Australia excels and collaborates is astronomy, particularly radio astronomy.

In recent years, Australia has been chosen to co-host the Square Kilometre Array (or SKA), the largest and most capable radio-telescope ever constructed.

Designing and implementing the SKA will require the expertise of a global team of astronomers. But, more than that, it will require a highly qualified, multi-disciplinary team to meet the many challenges associated with this next-generation project.

Engineering will play a critical role. Electrical and electronics engineers will balance the power requirements of thousands of dishes and antennas, power engineers will design methods of delivering this power from renewable sources, software and computer systems engineers will address the immense computing requirements of the SKA and systems engineers will design and manage the project over its lifetime.

The Australian SKA supercomputing facility will be housed in the Pawsey Supercomputer Centre in Perth and will need to be 50 times faster than any current supercomputer.

Transmitting the data from the telescope to the supercomputing centre is another engineering challenge. As are energy supply, heating and cooling.

The SKA is a large, challenging project that will need significant scientific and engineering advances to be realised.

It is this ambition that has served Australia and humanity so well in the past.

But we can no longer presume that we will always have the means to realise that ambition.

We cannot reside in a torpor that has us thinking that because the past was OK and the present isn't too bad, then the future will look after itself.

We cannot simply expect to have the right people in the right place at the right time to do the things we need them to do.

Take engineering education as one example.

Engineering courses continue to attract high quality undergraduates. Statistics suggest that the demand-driven approach to university funding has not affected the quality of students applying to study engineering.[4]

Students with high ATARs still want to study engineering and pursue it as a profession.

While that suggests a healthy flow of talented, dedicated minds into the discipline, there are some issues that continue to call for our attention.

One is whether the quality of graduates <u>commencing</u> tertiary engineering programs is translating into an adequate completion rate.

Do students entering an undergraduate engineering course have the requisite skills to tackle course content and graduate? How concerned should we be that 40 per cent of students starting engineering do not complete their degree?[5]

What's contributing to this scenario? There are probably multiple answers.

It might start early on - consider how we spend less than three per cent of primary school teaching time on science on average and something like 18 per cent on 'mathematics', is it possible that we are not adequately preparing our cohort of engineering undergraduates from an early age?

[4] *The engineering profession: A statistical overview*. Engineers Australia, Tenth addition, September 2013.
[5] *The Health of Australian Science*, Office of the Chief Scientist, May 2012, pg 72.

Time spent is one thing; teaching is another.

We ask students to choose early in secondary school what subjects they will study, and we offer few incentives to get students interested in subjects that are important to our future when they are in decline or stagnant.

One of the key issues for engineering education is how many Year 12 students are choosing to study science and maths subjects, and at what level.

Australian Deans of Engineering are as concerned as I am about the long-term downward trend in year 12 enrolments in advanced and intermediate mathematics.[6]

In 2011, only 9.6 per cent of students took advanced mathematics subjects, compared to 14.1 per cent sixteen years ago.[6]

This is not an issue that can be tackled by a single educational sector. Encouraging year 12 students to study science and advanced mathematics subjects would likely mean addressing;

- The time spent teaching science to primary school students
- The attitude of teachers, careers counsellors and parents that influence student choices
- The prerequisite subjects required for university admission

[6] *The engineering profession: A statistical overview*. Engineers Australia, Tenth addition, September 2013

- The societal view of science, technology and mathematics

Another issue is the gender gap in engineering enrolments, which continues to be significant.

Women made up only 15 per cent of domestic commencing engineering students in 2011, a proportion that has not changed since 2001.[7]

While I have highlighted a couple of issues, I do not want to elevate them to more or less important than others.

The question I want to pose is: Can we imagine a better way, and can we imagine it on the scale required to make a difference?

If we can, then what we need to do is invest in the <u>whole</u> STEM enterprise – all levels of STEM education and research.

This includes our research priorities and funding, industry focus, and the understanding and support of STEM by the Australian public.

In recent months I have been proposing that we should commit to developing a long-term and cohesive national strategy for STEM in Australia.

Such a strategy would result in the coordination of our support for STEM by ensuring that we consciously deploy our

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[7] *The engineering profession: A statistical overview*. Engineers Australia. Tenth addition, September 2013

resources for maximum benefit, and that gaps in the pipeline anywhere from early education to strategic international alliances are known and accepted – or rectified.

It is an approach similar to the National Science and Technology Council (NSTC) in the U.S.

The NSTC is a Cabinet-level council and is the principal means within the executive branch to coordinate science and technology policy across the diverse entities that make up the U.S. Federal research and development enterprise.

Chaired by the President, membership also includes the Vice President, the Director of the Office of Science and Technology Policy, Cabinet Secretaries and Agency Heads with significant science and technology responsibilities, and other White House officials.

A primary objective of the NSTC is the establishment of clear national goals for Federal science and technology investments in a broad array of areas spanning virtually all the mission areas of the executive branch.

It is this model, operating in this way and with this kind of authority that makes sense for us to adopt here in Australia.

If you look at our Federal Budget, STEM is spread over multiple portfolios. We need to be coherently strategic about STEM and its growth and development.

I believe one option could be for the Prime Minister's Science, Engineering and Innovation Council (PMSEIC) to take on a role similar to the NTSC, in order for us to oversee an agreed strategic approach.

We need an approach like this if we are to continue to build infrastructure that is sustainable, if we are to support programs with foresight, if we are to invest in public and private works that complement one another in the national interest.

So while we celebrate our achievements – be they massive engineering projects or incremental improvements – we must not be complacent about retaining our capacity to continue advancing our nation's interests.

What we design, invent, create and build today, will be the engineering heritage of tomorrow. It is important that we get it right.