Australian Government

AUSTRALIA'S CHIEF SCIENTIST

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Good morning

I've been asked to talk on the topic "Challenging Tomorrow - the role of the engineer & scientist in society"

Given there are so many chemical engineers and industrial chemists gathered here this morning, I'd like to start by noting the important contribution you are all presently making to Australia.

The chemicals industry is crucial to Australia's prosperity. I can think of few others so intrinsically linked to science and to the prosperity of Australia.

Economically the outputs of chemical engineering are enormous for Australia. Few other areas of science contribute so directly to our industrial successes.

Chemicals (and plastics) are essential inputs to all but two of Australia's 111 industry codes[1].

It is the second largest manufacturing industry in Australia, with a contribution of $11.6 million to GDP in 2010-11[2], and provides jobs directly for around 60,000 Australians[3].

[1] CSIRO, 2013. Strategic Directions – towards sustained growth of the Australian chemicals and plastics industry. p3 using 2012 ABS data
[2] Ib id, p5
[3] PACIA *Strategic Directions* Report – Pg 5

As the Plastics and Chemicals Industries Association (PACIA) says, “Without access to chemical and plastic products, the Australian economy would likely grind to a halt”[4].

With such ubiquity, this industry has the opportunity improve the life of Australians almost more than any other.

Regardless of whether it’s in medicine or energy, computing, or transport – your sector’s involvement leads to products and services that make people’s lives better, healthier and safer.

Unfortunately, like any industry, yours too faces challenges. One is securing a workforce with the necessary skills.

Australia needs trained chemical engineers and technicians to work in food processing, food packaging, recycling, mining services, healthcare and construction.

Countries such as China, India, South Korea and Singapore are increasing many of these skills at a faster rate that Australia and are thereby gaining a competitive edge.

If Australia loses its capabilities in chemical engineering they will not easily be regained in the future.

Surveys by Engineers Australia – a peak national professional body – reveal that 70 percent of employers in Australia

[4] CSIRO, 2013. Strategic Directions – towards sustained growth of the Australian chemicals and plastics industry. p 5.

"experience difficulties" recruiting engineers of all types - including chemical engineers[5]

While we face significant competition for these skills in our region, other nations like the U.S. are also putting in place measures to try and bolster capacity.

President Obama says, and I quote: "With the pace of technological innovation today, we can't afford to stand still for a year or two years or three years. We've got to seize every opportunity we have to stay ahead. And we can't let other countries win the race for ideas and technology of the future.[6]"

If the US, the world's biggest scientific producer cannot afford to stand still, you can bet that Australia needs to be doing a lot more.

It is no secret that I admire the US system immensely. The US supports a culture of inspired risk taking, a culture that respects intellectual curiosity and creativity.

Right now ours is a lot of what we used to do, just fiddled at the margins. But it's time has passed.

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[6] Remarks by the President on the 150th anniversary of the national academy of sciences. April 29, 2013. Available: http://www.whitehouse.gov/the-press-office/2013/04/29/remarks-president-150th-anniversary-national-academy-sciences

That's not just true for chemical engineering specifically or science generally, but all of STEM: science, technology, engineering and mathematics

I want to come back to the idea of challenging tomorrow and the role of scientists and engineers, but first let me give you a thumb nail sketch of the present.

STEM contributes to a better society, economy and nation.

We know that science-related study prepares a student for a lifetime of critical thinking, and promotes a drive to find evidence and develop and understanding of our natural world and our constructed world.

And I think it is important to note that STEM skills are not only needed in STEM occupations, but in other economic sectors as well[7].

A report done for the UK's House of Lords says *… the workforce of the future will increasingly require higher-level skills as structural adjustments in the economy force businesses to move up the value chain. These jobs of the future will increasingly require people with the capabilities that a STEM qualification provides.*[8]

Increased mobility and shared training events including business as well as students and staff from the education

[7] ACOLA, STEM: Country Comparisons, page 133 – US report.
[8] ACOLA, STEM: Country Comparisons, page 129.

sector will foster higher levels of STEM and innovation performance.[9]

If we are to have productivity growth, we need people to be working smarter rather than just harder.[10]

It should come as no surprise that a lack of skilled people is the highest single reported barrier to innovation in Australian businesses[11].

Specific to STEM, Australia is struggling with[12]:

- declining secondary school participation rates in the enabling subjects of mathematics, chemistry and physics;
- looming shortages of capability as a consequence of the ageing academic staff profile; and
- a gender imbalance in the enabling sciences, with women accounting for smaller percentage shares in scientific careers and at senior academic levels.

There are concerns worldwide that the numbers and quality of STEM graduates may be inadequate.

As The Australian Council of Learned Academies (ACOLA) says:

[9] OCS STEM Strategy, page 20
[10] Australian Innovation System Report, 2012, page 30 – ref Productivity Commission
[11] Australian Innovation System Report, 2012, page 31 – ref Australian Bureau of Statistics
[12] OCS, Health of Australian Science, 2012.

- …the question of demand and need for STEM qualifications turns in part on the economic role envisioned for STEM. Some analyses position STEM qualifications as end-on with STEM-specific occupations. Others, including the Council for Industry and Higher Education (CIHE) in the UK, see STEM graduates as economically valuable regardless of whether they go into a STEM-specific career or not. In this context boosting STEM is seen as a means of broadly boosting workforce quality.[13]

In Australia, STEM graduates have high employment rates (81 per cent) and low unemployment rates (4 per cent) compared to graduates from most other disciplines. This is consistent with patterns in other countries.[14]

Less than two thirds of recent STEM graduates work in jobs that are directly matched to their education. Engineering graduates are the most likely to be working in their field of training (79 per cent in 2011) compared to computing graduates (60 per cent) and graduates in the natural and physical sciences (44 per cent).[15]

I hasten to add that this is not considered a failure elsewhere.

[13] ACOLA, STEM: Country Comparisons, page 128.
[14] ACOLA, STEM: Country Comparisons, page 131.
[15] ACOLA, STEM: Country Comparisons, page 132.

I aspire to having a better level of understanding in this country about how STEM generates the knowledge that contributes to the economy and innovation.

So now to this question of challenging tomorrow. What will the future look like? What will the role of scientists and engineers be in this future?

The first thing to say is that STEM is critical to our future, but it does not operate in isolation.[16]

To effectively address challenges and provide benefit to Australia, STEM has to work for and with society.[17]

Acceptance by the community of the outcomes from STEM will only arise when the community has confidence in Australia's STEM enterprise This will be advanced through commitment to a social compact within which all the key enablers (governments, community and STEM practitioners) understand their obligations to each other.[18]

We know that success in the 21st century is driven by excellence in science, engineering and innovation – by pushing the boundaries of knowledge and by applying discoveries to produce new or improved products and processes…[19]

[16] OCS STEM Strategy, page 12
[17] OCS STEM Strategy, page 12.
[18] OCS STEM Strategy, page 12.
[19] State of the Nation, Canada's Science, Technology, and Innovation System: Aspiring to Global Leadership Science, 2013; Technology and Innovation Council, Advisory Council to the Government of Canada, p 5.

The most competitive economies are built on the recognition that science, engineering and innovation drive growth, prosperity and high quality of life.[20]

But innovation does not just happen. Others are not leaving it to chance and nor should we.

A strong, dynamic and sustainable Australian STEM research enterprise will provide a foundation for innovation and strong business performance, stimulate the development of new products, processes and businesses, and provide the deep technical knowledge that underpins a resilient economy.[21]

We need to do better. Almost all other OECD countries are much more likely than Australia to develop innovations that are new to international markets.[22]

So how do we get better? If we want to improve our capacity to innovate, we need to change our culture.

We need better integration of the public and private STEM sectors to strengthen the innovation system. A focus on STEM-based innovation and its global reach will help build resilience into the Australian business and economy.

[20] State of the Nation, Canada's Science, Technology, and Innovation System: Aspiring to Global Leadership Science, 2013; Technology and Innovation Council, Advisory Council to the Government of Canada, p 5.
[21] OCS STEM Strategy, page 20
[22] Department of Innovation, Industry, Science and Research (2012) Australian Innovation System Report 2011, Australian Government, Canberra.

Australian businesses play a key role in STEM R&D. For every $1 invested by the public sector in R&D, business invests $2 in business R&D.[23]

A 1% increase in public R&D would result in a 0.28 percentage point increase in the long run rate of productivity growth.[24]

Here in Australia, business sector R&D is focused on applied research – 94% of expenditure.[25]

In the public sector, 50-70% of expenditure is on applied research or experimental development, with the rest concentrated on discovery-led or 'basic' research.[26]

Total research expenditure on applied research or experimental development has grown five-fold since the early 1990's, whereas pure basic research and strategic basic research expenditure has grown two and three fold respectively over the same time period.[27]

Other nations have recognised that higher education, research and innovation systems that are more tightly linked to economic development are a pre-requisite for a knowledge economy.[28] If we aspire to have one, we must ask ourselves if we recognise that link.

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[23] Bochove, C.A. van, Centre for Science and Technology Studies, 2012 Working Paper Series, http://www.cwts.nl/pdf/CWTS-WP-2012-003.pdf
[24] OECD (2006) *Sources of Knowledge and Productivity: How Robust is the Relationship?* STI working paper.
[25] Australian Innovation system report, 2012, page 22.
[26] Australian Innovation system report, 2012, page 22.
[27] Australian Innovation system report, 2012, page 22.
[28] OECD Programme on Innovation, Higher Education and Research for Development, http://www.oecd.org/sti/49603459.pdf

In Australia, innovation performance is weakened by the limited collaboration between firms and universities.[29]

- The OECD recommends that enhancing innovation policy should be a key priority in economic reforms. The OECD specifically recommends to:

  introduce new, easy to use measures to complement existing support mechanisms to boost business-research collaboration.[30]

Only when all aspects of the innovation pipeline work together effectively will the true contribution of science, engineering and technology to the economy be realised.

In the US, there is recognition that sustainable growth is built from long-term investments. The National Economic Council there says:

- A short-term focus has neglected essential fundamental investments[31]
- A short-term view of the economy masks under-investments in essential drivers of sustainable, broadly-

[29] OECD, Country notes, Economic Policy Reforms 2013: Going For Growth, http://www.oecd.org/eco/growth/Australia.pdf
[30] OECD, Country notes, Economic Policy Reforms 2013: Going For Growth, http://www.oecd.org/eco/growth/Australia.pdf
[31] National Economic Council, A Strategy for American Innovation: Driving Towards Sustainable Growth and Quality Jobs, http://www.whitehouse.gov/administration/eop/nec/StrategyforAmericanInnovation

shared growth. It promotes temporary fixes over lasting solutions.[32]

- Too many children are not getting the world class education they deserve and need to thrive in this new innovative economy.[33]
- Innovation is also crucial for maintaining the dynamism and resilience of our economy. Future challenges are impossible to predict, but what is certain is that an economy better able to switch gears, innovate solutions, and re-deploy old activities, jobs, and industries will be least susceptible to adversity.[34]
- Innovation is the key to global competitiveness, new and better jobs, a resilient economy, and the attainment of essential national goals. A strategy is clearly needed to direct our government's funding and regulatory decisions in order to capture the innovation opportunity.[35]
- The true choice in innovation is not between government and no government, but about the right type of government involvement in support of

[32] National Economic Council, A Strategy for American Innovation: Driving Towards Sustainable Growth and Quality Jobs, http://www.whitehouse.gov/administration/eop/nec/StrategyforAmericanInnovation
[33] National Economic Council, A Strategy for American Innovation: Driving Towards Sustainable Growth and Quality Jobs, http://www.whitehouse.gov/administration/eop/nec/StrategyforAmericanInnovation
[34] National Economic Council, A Strategy for American Innovation: Driving Towards Sustainable Growth and Quality Jobs, http://www.whitehouse.gov/administration/eop/nec/StrategyforAmericanInnovation
[35] National Economic Council, A Strategy for American Innovation: Driving Towards Sustainable Growth and Quality Jobs, http://www.whitehouse.gov/administration/eop/nec/StrategyforAmericanInnovation

> innovation. A modern, practical approach recognizes both the need for fundamental support and the hazards of overzealous government intervention.[36]

Innovation is about people: the knowledge, technology, infrastructure, rules and cultures they have created or learned; who they work with; and what new ideas they are experimenting with.[37]

Much of the world is preparing for a future more dependent on science, technology, engineering and mathematics (STEM).

There is anxiety about being left behind if strategic action is not taken. The development of STEM is not being left to chance elsewhere.

Many of the countries we collaborate and compare ourselves with are taking urgent and planned actions to improve their skill and knowledge base in any or all of STEM.

Their aim is to develop their capacities in STEM to provide a strong knowledge base to secure a prosperous future for their citizens.

The various strategies are different, of course, but there are some broadly common themes, including:

[36] National Economic Council, A Strategy for American Innovation: Driving Towards Sustainable Growth and Quality Jobs, http://www.whitehouse.gov/administration/eop/nec/StrategyforAmericanInnovation

[37] Australian Innovation system report, 2012, page 33.

- Plans to equip their education system to prepare the increasingly STEM-dependent workforce of tomorrow;
- Plans to ensure a steady flow of new ideas, and encouraging innovation;
- Plans to align research and innovation with areas of comparative advantage and national need;
- Plans to form international alliances to address shared priorities and challenges.

We could rest on our laurels only if the rest of the world was doing the same. It is not.

The choice is ours: we can presume that because the past was OK and the present isn't too bad, then the future will look after itself. Or we can aspire to a future better than it would otherwise be and develop a strategy to achieve it.

Two months ago I released a position paper - *Science, Technology, Engineering and Mathematics in the National Interest: A Strategic Approach.*

It received support from not just education, science and research stakeholders but also from the Business Council of Australia.

One of the recommendations in the BCA's *Action Plan For Enduring Prosperity* is and I quote ... to "Implement the National

Science, Technology, Engineering and Mathematics (STEM) Strategy called for by the Chief Scientist of Australia. This will enable a whole-of-government approach to coordinating STEM policies, prioritising public investment and adopting an incentive structure that encourages growth in business investment”

I followed the launch of the paper up with a widely-distributed series of (well received) bulletins, as well as a joint op ed column with Jennifer Westacott of the BCA published in the *Australian Financial Review*.

There was renewed interest in the position paper two weeks ago when the Government announced its cabinet and a few people expressed concern about the lack of a minister who had “science” in their title.

I was asked about it on *Lateline* and what I said then remains my view, that science is administered over 14 portfolios already which means that what we really need is a strategic approach to the development of science.

I’d like to see several ministers, with the support of the Prime Minister, build up that strategic approach, take a different view from the view that we've traditionally taken in Australia and for us to be coherently strategic about science and its growth.

I am proposing is a similar approach to how science is administered in the U.S., where the National Science and Technology Council (NSTC) operates at Cabinet level.

It is the principal means within the executive branch to coordinate science and technology policy across the diverse entities that make up the Federal research and development enterprise.

The Council is Chaired by the President, with membership including 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.

I’m hoping that the Prime Minister's Science, Engineering and Innovation Council (PMSEIC) might take on a similar role in order to provide the whole-of-government strategic vision we need.

That is what I am working towards. Of course for us to be strategic about the growth and development of STEM, we need scientists and we need engineers contributing at every level, right across the spectrum.

If we get all this right, we need not worry about challenging tomorrow but rather be confident that we are better-placed to secure tomorrow.

Thank you.