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AUSTRALIA'S CHIEF SCIENTIST

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********** CHECK AGAINST DELIVERY **********

Good afternoon. It is good to be back. I think that this is my fifth time here – and I hope that **I** will enjoy this one as much as I have the others. And I hope that **you** enjoy this one more than you have the others.

Today, I am launching a position paper urging a strategic approach to Science, Technology, Engineering and Mathematics (which I will call STEM) in Australia. For those who do not have a copy but who do have an interest, the paper is available on the website of the Office of the Chief Scientist.

For today, I have planned a talk, this launch, in essentially three parts.

The first part is a question - with some supplementaries to show that I have learnt something by coming here over the years. The second part will be an assumption flowing from my answers to the first; and the third will be a way forward – a path we could choose to follow.

The headline question is simply put: *what sort of Australia do we want?* Do we want to build one that provides the coming generations with the opportunities and the lifestyle

that many of us have enjoyed, or do we not particularly care?

Do we accept that we can plan a better future than we might otherwise have? Do we want to position Australia securely in a competitive even hostile world? Or do we lapse into some sort of torpor based on the delusion that if the past was OK, and the present isn't too bad, then the future will look after itself?

In case I have left you in any doubt, I am firmly in the camp that thinks we have to act. I think that we have to take as much control of our destiny as we can. Because I think that if we don't, we will be left behind. Being at the back of the pack is no place to be if you want to take a mark, or even to make a mark, my old coach used to say. It was correct then, and it still is now.

I believe that we have to work to earn a future that we ourselves would enjoy. And **earn** is the word.

The need to move is illustrated by some simple facts of life: there is no entitlement to a particular future; there will be no free ride on the back of the accomplishments of the rest of world; or on the back of our own resources. We could rest on the oars, of course, but **only** if the rest of the world was doing the same. But much of our world is not.

Indeed, the countries that we might compare ourselves with show a sense of urgency – an anxiety if you like – about **not** being left behind – so they are **not** sitting back resting and drifting with the tide, they are making things happen. Some are even trying to make the tide turn -- their way.

And they are aiming to do that by attending to their STEM enterprise – all of it, education, research and innovation. There is no presumption that past practice will be good enough; there is no presumption that the future can be taken for granted.

Let me illustrate the point briefly.

Former Prime Minister Rocard of France in 2007: *because Europe's future is at stake, decision-makers must demand action on improving science education from the bodies responsible for implementing change.*[1] A national research and innovation strategy was introduced two years later.

Commissioner Geoghan-Quinn of the EU in 2011: *We cannot risk our future growth and competitiveness by cutting back now on investment in education, research*

[1] Rocard, M et al (2007) Science Education Now: a renewed education for the future of Europe. *http://ec.europa.eu/research/science-society/document_library/pdf_06/report-rocard-on-science-education_en.pdf*

and innovation that is necessary for long-term and sustained recovery.[2]

And Commissioner Vassilou also of the EU in 2012: *Many international reports identify the potential shortage of human resources in key scientific professions...*[3]

The EU has plans[4] and it has strategies.[5]

Canada released a strategy in 2007 and a follow-up report in 2013[6] identified a need to increase *the number of doctoral degrees in science and engineering per one hundred thousand of the population.* I note that they already have some 20% more than Australia.

The US has been particularly active. The most recent example is a 5–year strategic plan presented to the National Science and Technology Council in May 2013.[7]

The plan reflects *the needs of our nation, the alignment of priorities of both the Administration and Congress and can*

[2] M. Geoghan-Quinn (2011) European Commissioner for Science, Research and Innovation: Promoting Excellence in Science under Horizon 2020. Tyndall National Institute Cork.
[3] European Coordinating Body in Maths, Science and Technology (2012) Ingenious Press Conference. *http://www.ingenious-science.eu/web/guest/press-release*
[4] European Commission (2013) The EU Framework Programme for Research and Innovation. *http://ec.europa.eu/research/horizon2020/index_en.cfm?pg=h2020*
[5] European Commission (2013) EU International Strategy for Research and Innovation. *http://ec.europa.eu/research/iscp/index.cfm?pg=strategy*
[6] Science, Technology and Innovation Council (2012) Canada's Science, Technology and Innovation System: Aspiring to global leadership.
[7] Committee on STEM Education, National Science and Technology Council (2013) Federal Science, Technology, Engineering and Mathematics (STEM) Education: 5-year Strategic Plan.
http://www.whitehouse.gov/sites/default/files/microsites/ostp/stem_stratplan_2013.pdf

draw effectively on Federal STEM-related assets. Even before that, the US had committed resources to produce 100,000 new STEM teachers, and one million additional graduates in STEM over the next decade.

A report from Georgetown University summarises the US position as follows: *Our education system is not producing enough STEM-capable students to keep up with demand both in traditional STEM occupations and other sectors across the economy that demand similar competencies …* It goes on...*the observation that the market for STEM competencies is broader than the market for STEM workers, illuminates why we look like we're producing enough STEM workers – but we are actually not.*[8]

I note in passing that they do not see it as a failure if STEM qualified individuals do not work in STEM related occupations.

Closer to home, Asian economies with very high performing education systems *have established national policies around science and technology more broadly, and university and industry driven research and development.*[9]

[8] AP Carnevale, N Smith, M Melton (2011) STEM: Science, Technology, Engineering and Mathematics.

[9] Australian Council of Learned Academies (2013) Snapshots of 23 Science, Technology, Engineering and Mathematics (STEM) consultants' reports: Characteristics, lessons, policies and programs.
http://www.acolasecretariat.org.au/ACOLA/PDF/SAF02Consultants/Consultant%20Report%2

China has adjusted its Science and Technology strategies to align them better with their overall national strategy and the goals for economic and social development.

The Chinese Plan[10] notes that: *The scientific spirit and qualities of a nation determine the future and vitality of the nation.*

India's strategy[11] plans to raise Gross Expenditure in Research and Development (GERD) to 2% of GDP from the present 1%; and also plans to increase the number of Full Time Equivalent personnel in R&D by at least 66% of the present strength in 5 years.

All these countries have strategies, as do the UK, Japan, Taiwan, the Scandinavian countries, Switzerland and more. Of the sixteen countries we looked at, two thirds of them have overarching bodies to coordinate programs.

And in Australia - the conversation continues. The Australian Industry Group reported in 2013 that it *Yet this… report reveals a disturbing picture in this area.*

0%20Snapshots.docx.pdfwww.ACOLAsecretariat.org.au/ACOLA/PDF/SAF02Consultants/Consultant%20Report%20-%20Snapshots.docx.pdf

[10] ibid

[11] ibid

Young people in schools and universities are not acquiring the STEM skills we need for our future prosperity.[12]

A report by the Australian Council of Learned Academies (ACOLA) summarises the overall position as follows: *Most nations are closely focused on advancing STEM, and some have evolved dynamic, potent and productive strategies. In world terms, Australia is positioned not far below the top group, but lacks the national urgency found in the United States, East Asia and much of Western Europe, and runs the risk of being left behind*[13]*.*

It should be clear. This is no world for the lethargic. No world for the complacent. No world for the unambitious. We need to act.

The back of the pack is no place for a nation that presently produces just 3% of the world's research output. That solid but not outstanding performance means that Australia's STEM enterprise must be globally connected to maximise advantage – to contribute our talents and insights as we draw benefit from those of the global community as we search for solutions to problems that confront us **and** confront the planet.

[12] Australian Industry Group (2013) Lifting our Science, Technology, Engineering and Mathematics (STEM) skills.
[13] Australian Council of Learned Academies (2013) Securing Australia's Future: STEM Country comparisons.

So to the second part of the talk.

My assumption is that we have to change, and that part of the change will require us to think and act more strategically about Australian STEM – and its quality - at all levels.

But how? Well, I agree with the view of the Committee on Science of the US House of Representatives: *no entity as vast, interconnected, and diverse as the science and engineering enterprise can successfully operate on auto-pilot perpetually.*

It is noteworthy that the US does not leave it all to chance. Ten years ago, it established the National Science and Technology Council (which is a Cabinet-level Council chaired by the President, the membership of which includes the Vice-President, the Director of Office of Science and Technology Policy, Cabinet Secretaries, Agency heads and other officials) and is (I quote) *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 prepares research and development strategies that are coordinated across*

Federal agencies to form investment packages aimed at accomplishing multiple national goals.[14]

Our paper does make the point that the Australian federation has no such Council, and suggests that the Prime Minister's Science Engineering and Innovation Council (PMSEIC), could be structured and referenced to undertake the role if there is no wish to create a new body.

Whichever way we might seek to introduce such an enlightened approach in Australia, I do think that it will take sensible and sensitive coordination - and strategic and sensitive intervention by governments.

The consequence, though, would be a harmonised array of activities and programs collectively and coherently aimed at one outcome – an Australia better than it would otherwise be – one that can provide an enviable future for all, and one with a secure place in a changing world.

The performance of our students would be high. And the disciplines that underpin STEM would be strong and taught with inspiration by teachers who are supported to keep abreast of their field – a regular exposure to contemporary knowledge in their disciplines.

[14] Office of Science and Technology Policy (2013) National Science and Technology Council. *http://www.whitehouse.gov/administration/eop/ostp/nstc*

By 2025 we should have reached a point where Australians will better understand and value the science they use in everyday life, and where the STEM enterprise will be widely accepted as a central and visible source of solutions to societal challenges.

The education system will provide all Australians with the capacity and confidence to make informed choices on complex matters where STEM offers options that have ethical, economic or environmental dimensions. We could even aim to see Australians generally (to quote the Taiwanese Plan) *take delight in learning science and understand the application of science, be curious about the profoundness of science and appreciate the beauty of science.*[15] Many more would be eager for advanced study in STEM were it like that.

Australia by then will have a well-qualified and diverse STEM workforce; and we will be well served by effective STEM linkages between the research and innovation sectors.

We will support our best researchers at a level that will enable them to take a place alongside their best

[15] Australian Council of Learned Academies (2013) Securing Australia's Future: STEM Country Comparisons. Report of Taiwan: STEM (Science, Technology, Engineering and Mathematics). *www.ACOLAsecretariat.org.au/ACOLA/PDF/SAF02Consultants/Consultant%20Report%20-%20Taiwan.pdf*

international peers. Australian STEM will be deeply and strategically connected globally, and we will be offering the world much.

And we will know that, no matter how good we are, for the full benefits to flow to our community, we need to have the confidence and the trust of that community.

So let me turn to the third part of the talk: an approach to developing the STEM we need for our ambitions for our country to be realised.

I say at the outset that if you are looking for targets in our paper, and decimal points, or even offsets, you will be disappointed. This is a call for a Strategy.

I also know that I will be told that this bit or that bit is already done or being done in in prospect. Firstly, it could be true – we do quite a few things well in Australia. But what we need now is some persistence; some medium to long-termism - well beyond the exigencies of the moment and this or that terminating program.

I do look forward to the discussions that will follow from this release.

The **Approach to a strategy**.

I start with what I think to be a key element - a social compact.

I am conscious that Carl Sagan (a US Astronomer) was not alone when he said: *We live in a society exquisitely dependent on science and technology, in which hardly anyone knows anything about science.*[16] In this context, we can't take community support for granted – or expect that the community will accept what we say just because we say it.

The investment in STEM education and research must therefore complement valuable work in the social sciences and humanities, work that is critical to our understanding and recording of our world, our cultures and our knowledge of society and relationships within society. It is work that we need in order to understand the societal context within which STEM operates – and it is that context that will shape the social compact – and therefore the extent to which STEM can be effective.

I do not, mind you, suggest that the concept of a compact is new – there has long been a tacit one. Nor do I argue

[16] Sagan, C. (1990) The Skeptical Inquirer: Why we Need to Understand Science, Volume 14, Issue 3.

that the bulk of Australian scientists do anything other than work with total integrity. And I do know that the peer community has shown that it will deal with the few who don't take their responsibility seriously.

I do argue, however, that the community needs to know that it happens, and how. And when they know that the peers, the group with deep expertise, are rigorous about standards and integrity, their confidence will result in a community that widely respects science (or more properly STEM) and the evidence of experts.

Tony Blair then PM of the UK once said in an address to the Royal Society: *The benefits of science will only be exploited through a renewed compact between science and society, based on a proper understanding of what science is trying to achieve.*[17]

In the same context, indeed, in the same speech, he said: *Science doesn't replace moral judgement. It just extends the context of knowledge within which moral judgements are made. It allows us to do more, but it doesn't tell us whether doing more is right or wrong.*[18]

[17] Blair, T. (2002) Speech on scientific research to the Royal Society. http://www.guardian.co.uk/politics/2002/may/23/speeches.tonyblair
[18] Ibid.

I have argued for some time (though not as elegantly as Tony Blair) that STEM will be of most benefit **to** the community when it operates with a social licence **from** the community. In other words a licence provided when the community understands the why, the what, by whom and for what purpose - **and** has confidence in the safeguards and the regulations. Hopefully it will also be a community willing to demand that the 'Australian team' be supported at a level commensurate with its responsibilities.

The community may not always like the message the science delivers: but it does need the confidence to see **why** they'd be wise to listen to the experts – to the robust exchanges between experts. Then it can decide *whether doing more is right or wrong* based on evidence not decibels.

Confidence and trust should not be taken as a given; and winning it, earning it, should not be taken as an easy ride.

So far today:

- I have tried to show that we need to be clear about why we do all this – the end game: making Australia better than it would otherwise be.

- I have illustrated what is happening in a number of other countries and drawn attention to the fact that we need to inject a sense of urgency in our national approach to STEM so as not to fall behind.

- I have highlighted the need for a refreshed social compact with the community so that the maximum benefits will flow to the community from the Australian STEM enterprise – the reason for the community to support us.

Now on to the rest of the '**how**.'

This part of the **'how'** has four elements, all of which are underpinned by the enabling sciences and mathematics. **And** by engineering and the technological sciences, which are at least in part based on the creative application of scientific principles leading to outcomes and inventions that do not exist in nature. It is the strength of these areas and disciplines that are the bedrock on which to build so much of our future.

The first element that brings it all together is education – where it all begins.

We rely a lot on our education system. It has to lay the foundations for all Australians; it has to prepare a STEM

literate community; it has to prepare and be part of the means by which we refresh constantly a STEM proficient workforce; it has to ensure that there are suitable numbers of Australians eager to become the STEM practitioners of the future.

We need to drive the education system away from educating students as we used to, and towards preparing students for a future increasingly bound to STEM.

<u>The second element is STEM and new knowledge.</u>

We need to ensure a continuous flow of new ideas. We need to understand the natural world, the constructed world and our community.

Government belongs here. Nowhere is that articulated better, than in an open letter to the then U.S. President from 21 leaders of US industry. They wrote: *History has shown that it is federally sponsored research that provides the truly 'patient' capital needed to carry out basic research and create an environment for the inspired risk-taking that is essential to technological discovery.*[19]

I envy both the prose and the signal.

[19] Congressional Record (1996) Volume 142, Number 139 (Tuesday, October 1, 1996). *http://www.gpo.gov/fdsys/pkg/CREC-1996-10-01/html/CREC-1996-10-01-pt1-PgE1888.htm*

The third element is STEM and innovation.

Almost all other OECD countries are much more likely than Australia to develop innovations that are new to international markets.[20]

If we want to improve our capacity to innovate, we need to change our culture.

We need to create better links between business and publicly funded research agencies and universities. And we need to ensure that there is a larger and better-prepared STEM-skilled workforce to work with our industries. This should be about partnerships and working together and understood differences – not sitting in our silo from which we forever lament the efforts of the others.

I agree with the Business Council of Australia whose paper released today calls for a National Innovation Council – and I look forward to continuing discussions with the Council. We have to make this work.

The fourth element is STEM and influence.

The world's challenges are shared. So are the solutions.

[20] Department of Innovation, Industry, Science and Research (2012) Australian Innovation System Report 2011, Australian Government, Canberra.

The G8 science ministers commented in June 2013 that *coordination of global scientific research is needed to address global challenges and maximise the social and economic benefits of research.*[21]

Our approach should be led by strategic and funded government-to-government alliances and by leveraging STEM and its global reach to strengthen Australia's position and our opportunity to contribute to a better world.

After all this, what next?

If I have managed to whet your appetite, you could as I said earlier go to the Office of the Chief Scientist website where you will find the full paper. In that you will find the objectives, actions and rationale in fuller form than time has permitted today.

Later in the year, and after a wide(ish) discussion, I will take a suitably amended version of the paper to PMSEIC. The practice from there is for the Prime Minister to task the relevant Departments and agencies with the development of the detail: the programs and implementation plans to put agreed strategic actions into

[21] UK Government, Foreign & Commonwealth Office (2013) G8 Science Ministers Statement https://www.gov.uk/government/news/g8-science-ministers-statement

practice. Some will doubtless go to the Cabinet for decision.

Let me finish by saying that we in Australia have a choice. We can act strategically to prepare a future we want, or we can settle back and persuade ourselves that what we do now will be good enough – just because we do it now.

If you choose as I would choose – that we need to take a concerted and strategic approach to Australian STEM - I ask that you keep the message alive out there and running for the next weeks and months.

I will be; I hope that you will join me.

Thank you.