



Australian Government

Chief Scientist

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The engineering way

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The engineering way

In my new role I try to pay a bit of attention to what's going on in Parliament. And I'm amazed by all the references to engineering!

Social engineering! Electoral engineering! Economic engineering!

And every now and then, though not often, there'll be a mention of engineering as the critical discipline we know it to be.

I wish we heard about it more often, because every parliament has a lot to learn from the engineering way. The *world* has a lot to learn from the engineering way.

I made this point in an opinion piece in the Australian Financial Review last week.¹

My office has just published the first comprehensive analysis of the science and engineering workforce in Australia: across VET, bachelor and PhD.²

This analysis demonstrates that a lot of science and engineering graduates don't work as scientists or engineers. And that's great! *Our disciplines teach valuable transferrable skills*. And I know it, because I have applied them every day of my life.

In US corporate boardrooms, I was hardly alone. Of the top 100 CEOs identified by the Harvard Business School in 2014, 24 had undergraduate or graduate engineering degrees.³

The Dean of the Harvard *Business* School, Nitin Nohria, is also an engineer. So we know that his analysis will be rigorous, evidence-based, insightful and, above all, *useful*.

Just think about the global impact of the engineering CEOs.

- Mary Barra, CEO of General Motors: electrical engineer.
- Sundar Pichai, CEO of Google and developer of the Chrome browser: metallurgical engineer.
- Jeff Bezos, CEO of Amazon: electrical engineer.
- And Andy Grove, legendary CEO of Intel and father of Silicon Valley, who passed away last month: chemical engineer.

Andy was a Hungarian Jew who escaped the Soviet Union after World War II at the age of 19: desperate and determined.

He co-founded Intel in 1968, and became CEO in 1987.

¹ Alan Finkel, "Are we properly using our STEM skills?" Australian Financial Review, 30 March 2016. Available: <http://www.afr.com/opinion/are-we-properly-using-our-stem-skills-20160330-gnttp3>.

² Office of the Chief Scientist 2016, *Australia's STEM Workforce: Science, Technology, Engineering and Mathematics*, Australian Government, Canberra. Available: <http://www.chiefscientist.gov.au/2016/03/report-australias-stem-workforce/>.

³ "The Best Performing CEOs in the World," Harvard Business Review, November 2014. Available: <https://hbr.org/2014/11/the-best-performing-ceos-in-the-world>.

At that time, the company's annual sales had fallen for four straight years. It was closing factories, laying off thousands of staff and running at a loss. By 1998, it was one of the world's most valuable companies. Its turnover had grown from \$1 billion to \$26 billion; and its market capitalisation had grown by more than 40 per cent a year to \$200 billion.

The big break came with the shift Andy engineered from memory chips to microprocessors.

And he was an engineer through and through. Pitching an idea to Andy was said to be "like going to the dentist and not getting Novocain".⁴ He demanded rigour and he didn't care about status.

Another interesting case is Jeff Bezos, named by the Harvard Business School as the best-performing CEO in 2014. He too is said to have engineering in his bones.

When he was three years old, he announced to his parents that he was sick of his crib and wanted a bed. His parents refused – rightly concerned by the thought of Jeff wandering free-range at night.

The next day when his mother came to wake him, she found a disassembled crib, a screwdriver and Jeff in the process of designing a new bed.

In hindsight, the Amazon business model was simply the logical extension.

So engineering as we know it is not simply a discipline or a profession. It is really a philosophy and a way of life.

- We value good communication, because we are engineers.
- We are passionate about education, because we are engineers.
- We are optimists, because we are engineers.

Yes, it helps us to run great companies – but it also makes it possible to help sort out the world.

When Toyota wanted to help out a New York community food bank, it didn't give money. It simply sent a team of engineers to observe the food bank at work.⁵

They recommended three simple tweaks to the queuing process – costing nothing and easily actioned - and they cut the wait time from 90 minutes to just 18.

A few engineers. One afternoon's work. An enormous impact on people's lives. And no whizz-bang gadgetry involved.

⁴ Jim Aley, "Remembering Silicon Valley's first giant, Intel's Andrew Grove," Bloomberg, 24 March. Available: <http://www.bloomberg.com/news/articles/2016-03-24/andrew-grove-the-first-giant-of-the-valley>

⁵ Mona El-Naggar, "In lieu of money, Toyota gives efficiency to New York charity", New York Times, 26 July 2013. Available: <http://www.nytimes.com/2013/07/27/nyregion/in-lieu-of-money-toyota-donates-efficiency-to-new-york-charity.html? r=0>.

So when I look at classroom of undergraduate engineering students, I don't assume I know what they'll be doing in ten years' time. I know they are building the toolkit to do anything at all, in the engineering way.

Imperatives for engineering education

I've thought a great deal about the health of engineering education in this country over the years, and I see much to celebrate today.

That doesn't mean our classrooms can't be better. We're scientists and engineers! We're *never* going to say it can't be better.

Let me highlight the two big imperatives I see for the decade ahead.

The first is harnessing technology in intelligent human ways.

There was a time when I thought that the future of the brick-and-mortar university was under existential threat. I know better now – and I should have seen it all along. *The basic human need hasn't changed.*

Think about the music industry. Yes, we've seen streaming replacing downloads, which replaced CDs, which replaced cassette tapes, which replaced vinyl records, which replaced the phonograph.

But none of them replaced live music.

We've simply developed progressively better ways of delivering music to individuals on tap. We haven't replaced our craving for social contact, live performance and a shared experience... all the richer for its human imperfections.

In the same way, students can get knowledge on tap from pre-recorded lectures and online textbooks. They'll still come to universities for the same reasons that students came to Oxford or Bologna in the thirteenth century. Great teachers. Great conversations. Big ideas.

In other words: human contact.

So the rowing machine at home hasn't replaced the gym. The Nespresso machine hasn't replaced the café. The MOOC won't replace the bricks and mortar university.

Technology's job is to make the human experience better.

Which leads to my second imperative: attracting people with all manner of career objectives into engineering.

Like my son. He wanted to go into business, to be a manager and a leader. I said that gave him two undergraduate degree options: engineering and law.

Now law would have been intuitive to most parents and career counsellors. That has a lot to do with the way that law degrees are marketed.

There are about 66,000 practising lawyers in Australia today. Every year, there are about 12,000 new law graduates. Which means that every five and a half years we graduate enough new lawyers to replace the existing workforce.

Now the kids who aim for law degrees are smart. If they all wanted to be lawyers... they'd see the problem.

They would also see the emerging reality of entry level roles in the legal profession. Oxford University analysis suggests that paralegals have a 97 per cent chance of being automated out of existence within two decades.

But law degrees are still highly sought and greatly valued: as qualifications that bring transferrable skills.

My wife intervened to deter my son from that path – but the logic we apply to law is no less true of engineering.

As I explained to my son, for young people who have interests ranging from a passion for social justice to revolutionising our car ownership model, they should think of engineering as a way to help them make their dreams come true. If they want to start a business, they should think of engineering as a useful skillset.

It is the twenty-first century toolkit for success – whether we are a toddler dismantling our crib, or an entrepreneur building a startup.

Conclusion

It's a dinner speech, so instead of challenging you to reinstate mathematics as a prerequisite for enrolment in your engineering degrees, my challenge to you is to spread the engineering way.

When you next welcome a group of first-year engineering students – all dewy-eyed with excitement – yes, of course, let's prepare them to be great engineers.

But let's also tell them the importance of studying engineering in order to become the next generation of great leaders – even Prime Ministers – that Australia needs.

Thank you.