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CHAPTER 9

Engineering

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We need to take that scientific ingenuity we are famous for and engineer our discoveries into new industries. These industries should be the bases of future technologies and next generation products that transform how we live and work.

Building the nation will be impossible without engineers

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Australian industries need the flexibility, insight and foresight that comes from thinking creatively, asking critical questions, forming and testing hypotheses and reasoning quantitatively — and engineers have the technical knowledge and the problem-solving skills to respond to constant change.

As they have a holistic understanding of the practical needs of communities, businesses and the environment, they are well positioned to work with other disciplines, including scientists and designers, to provide a stream of new ideas and technical responses essential for sustainable competitive industries.

But future knowledge-based industries won't just spring up because Australia's engineers are generally well regarded or because Australia's engineering degrees and professional associations are of high quality.

The ability of engineers to build Australia into the future — to literally build our modern infrastructure and to foster invention and innovation to support internationally competitive industries — will depend largely on changes that must occur over the next decade or so.

Australia's next generation of engineers, our school students, poorly understand the role of engineering and the importance of the sciences and the mathematics that underpin the ubiquitous technology that determines the way we live.

We have too few students studying science, technology, engineering and mathematics (STEM) subjects at higher levels at high school, too few going onto engineering at university, and a shortage of engineering skills across the economy as a consequence.

We can't just look to immigration to fill this gap; engineers are in demand across the world. Recent national efforts to promote STEM education are good news and are gaining ground, but we need to proactively continue to support capacity building.

The importance of a collaborative culture

From the university perspective we need to further enhance the engagement of engineering students with industry — beyond existing professional experience requirements within Australian engineering degrees — to produce truly 'work ready' graduates.

The OECD currently lists Australia in last place out of 33 nations for collaboration on innovation between businesses and the higher education sector and public research agencies.

This is a critical gap that we must address by providing substantial opportunities for students to undertake internships within a variety of industries and by bringing many more industry specialists and policy makers into the classroom to enthuse and inspire students.

This kind of holistic engineering education produces graduates who not only understand how to innovate but how to address the real world needs of both societies and industries.

To make sure we can respond competitively in the face of intense global competition, engineering education and research must be framed by the understanding of the economic realities and operating conditions that industries face that such deep engagement fosters.

From a business point of view, we need to change the way we think about our industries. The recent announcements ending car manufacturing in Australia are good examples.

That Australia will no longer manufacture cars is only a disaster if we are unable to identify and analyse what it took to make those cars, and apply this knowledge in another way.

So, instead of mourning the loss of 'big' industries defined by particular 'end products', we need to be constantly looking for creative, new opportunities along increasingly complex, evolving value chains.

Adding value

To create niche solutions that are smarter and more efficient requires both human and intellectual resources working within a vibrant culture of innovation. The key concept here is 'high-value output' which is not necessarily an 'end product'.

With consumer consumption driving the mass proliferation of high-tech products, we can be certain that these products will have some aspects in common such as various electronic components, which will in turn drive demand for the niche materials we need to make them.

Businesses might identify opportunities for diversification by making chips for various electronic products used in entertainment and health industries. Those car parts manufacturers could switch to making steel parts for complex equipment or for the beds used in hospitals, as the health-related industries expand with ageing populations.

What is critical here is expertise in making sophisticated steel parts, and the ability to recognise and take advantage of commercially viable opportunities to continue to use those skills as economies evolve (such as within the burgeoning health care sector).

Interestingly, this growing demand for health care services and related infrastructure and equipment and the explosion in electronics — that require high-value, niche inputs such as metal alloys — is converging as the health care sector depends increasingly on complex information technology and as more and more health services are deployed in the homes via sophisticated self-managed equipment and the remote monitoring of, and communication with, patients.

Likewise, when we think about the value chain, we need to think more creatively about how to incorporate the masses of potentially valuable materials we currently throw away as waste.

Not only are natural resources being depleted at an unsustainable pace, and carbon emissions rising, but industries recognise the cost-effectiveness of reusing materials. It will largely be engineers that can deliver previously unimaginable solutions.

It may not seem obvious, but alternative carbon sources, from waste plastics to used tyres — huge waste burdens globally — can be usefully transformed into value-added steel by partially replacing the conventional carbon source, non-renewable coke, in electric arc furnace steelmaking.

This 'green steelmaking' process, which I helped develop at the University of New South Wales, results in a more efficient furnace, reducing demand for power, and simultaneously transforming problematic wastes.

Greater than the sum of its parts

Equally, engineers can provide the technical expertise to support entrepreneurs pursuing their own ideas. Such a combination of engineering and business enables both areas of expertise to achieve much more together.

In my own experience working with our commercial partner to develop our 'green steel' making process, a whole range of

different professions were critical in ensuring that we captured the intellectual property (IP) we generated.

Protecting our IP has meant we were able to take our business case to the world, resulting in international commercialisation of our technology in collaboration with our industry partner.

Working in partnerships with other disciplines and with industries, engineers will create new knowledge, generate groundbreaking technologies, participate in research collaborations and training exchanges. This will ensure a rapid translation of knowledge into value for Australian industries.

This will create a culture of learning driven by innovative thinking, grounded in collaboration and built on the recognition that the dynamic changes in our world are inevitable.

If we are prepared to see change as a continuous cycle of new opportunities, not new problems, we will realise our aspirations. Future generations of engineers have much to contribute to ensuring new ideas and solutions lead to continuous improvement in quality of life, in Australia, and internationally.

Commentary by Robin Batterham

As a former Chief Scientist, I can be brave and push the line that ideas, as such, don't really affect our lives. Don't get me wrong — uncovering knowledge is important and we must play our part in generating and exchanging it. That said, it is the application of ideas in technology and science that impacts our livelihood.

Do you want to wind the emissions clock back without getting rid of six billion people? Then chat up the engineers, as what needs to be done also has to be economic and practical and innovative — the realm of engineers.

Moving from climate onto manufacturing: it is hardly the strong and vibrant core of Australia at the present, and yet it could be. Through Cooperative Research Centres (CRCs) and

other research groups and with industry associations, there is a renaissance of activity in high value add, agile manufacturing companies tackling the world's supply chains as they become more complex, demanding and internationally linked.

Be it communication systems, bionic devices or advanced composites, engineers are creating and driving success that benefits us all, economically, socially and with sustainability.

We just need more of them.

Commentary by Cathy Foley

Australia has an excellent track record of scientific discovery, but what are not as well recognised are the engineered outcomes that use this science.

From cochlear implants and sleep apnoea breathing machines to new chemical engineering processes that improve all plastics, Australia has some great examples of technology-led products that have global markets. But have we kept up with the times and is Australian engineering competitive enough?

We need to take that scientific ingenuity we are famous for and engineer our discoveries into new industries. These industries should be the bases of future technologies and next generation products that transform how we live and work.

We have this stereotypical vision of scientists with their heads in the clouds and engineers with their heads under the car bonnet. Imagine if we got better at connecting the science, the engineering and the investors, to turn our manufactured future into a modern, resilient, exciting and highly exportable commodity.

Australia is well placed to create an engineering-led boom — so let's do it.