

Developing Australia's advanced manufacturing capability

Engineers Australia submission to developing advanced manufacturing in Australia

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Engineers and advanced manufacturing

As production became commoditised, profits became harder to capture. Businesses looking for a competitive advantage through product design, manufacturing and sale of goods developed the concept of advanced manufacturing. In the future, the most successful manufacturers will adopt a combination of advanced knowledge, advanced processes and advanced business models.

Engineers have a direct influence on advanced manufacturing in Australia. Their involvement is multifaceted. Engineers create the systems, products and services which enable advanced manufacturing and industry 4.0 technologies. They also help integrate technological developments into current manufacturing processes. This allows manufacturers to do more with less, increasing their productivity and competitiveness.

In addition, much of advanced manufacturing's value is generated by the skills and knowledge of the engineering profession. Engineering is often the foundational aspect of advanced manufacturing.¹ Through an engineer's ability to innovate and problem solve, they engage in research and development, a preproduction aspect of advanced manufacturing which creates the greatest value. From here, having provided and proven the concept during research and development, the engineer will engage in design integration. Starting with analysis of advanced materials, the engineer will look for competitive advantage through assessing different material options. Through this assessment an engineer can consider circular economy principles, and product functionality by looking at aspects such as weight, strength and logistical compatibility. Selecting the best advanced material allows for pre-production design benefits. More traditional aspects of design will also be explored taking into consideration the above.

Australian manufacturing continues to receive greater attention recently as the public and government consider sovereign capability and manufacturing jobs as key to the Australian economy's future growth and resilience. To fully adopt this transformation a change of mindset is needed by manufacturers, particularly investing in technology and knowledge, by attracting and retaining staff with skills in digital literacy and STEM. This submission provides comments to the Committee's terms of reference.

About Engineers Australia

Engineers Australia is constituted by Royal Charter, to advance the science and practice of engineering for the benefit of the community. With over 115,000 members Engineers Australia is the trusted voice of a profession which impacts the lives of every Australian, every day.

Contact

Engineers Australia would appreciate the opportunity to engage with the committee further on this topic. Please contact Michael Bell, Senior Policy Advisor, at mbell@engineersaustralia.org.au or on +61 8 6214 6321 if you wish to discuss any points raised in this submission further.

¹ Refer to the Smiley Curve on the Advanced Manufacturing Growth Centre website which illustrates the production level and value added of advanced manufacturing: <https://www.amgc.org.au/our-purpose/about-advanced-manufacturing/>

Terms of reference

The opportunities of advanced manufacturing for Australia – including in relation to job creation, productivity and capability.

Australia's manufacturing sector is often undervalued, with many believing the sector to be smaller than it is. In fact, Australia's manufacturing industry contributes around \$100 billion to GDP annually.² As at the end of June 2021 the sector employed 839,000 people.³ Manufacturing is the second greatest contributor to business expenditure on research and development (BERD)⁴ and the sector recorded the second largest increase in R&D expenditure, up 4 per cent from 2017/18.⁵ Increasing goods offered and new services is an important part of the advanced manufacturing process which can make Australian manufacturers globally competitive.

The use of industry 4.0 technologies in advance manufacturing creates a real opportunity for Australia to compete with low-cost manufacturers from other countries. This is particularly the case for specialist or 'niche' products thanks to our educated and highly skilled workforce. Over 44 per cent of Australia's population aged between 25 and 34 are university educated.⁶ This is combined with higher education being a considerable contributor to R&D and comprising over a third of Australia's research. This sets Australia up to be competitive against lower cost labour economies by developing quality products using advanced manufacturing concepts created at a competitive price.⁷ The Advanced Manufacturing Growth Centre reports an increase in Australia's manufacturing value can come from local companies with a differentiated value proposition. The areas for businesses to upskill include innovative design, technical leadership, reliability and post-production intangibles, such as after sales service.⁸

An engineer's role in advanced manufacturing extends to the production and the post-production intangibles. Sales and service are often overlooked in advance manufacturing however, in a world of data, IP and servitisation,⁹ reviewing a manufacturer's business model to improve this highly valuable post-production intangible is highly beneficial and is made possible by advanced manufacturing.

While the importance of sales is often overlooked as a profession, contributing to the success of Australian manufacturing, the reality is, outside of fashion, fast moving consumable and durable household goods, many sales positions fall into the technical category. For technical products this often relies on engineers who have an ability to sell and are valued for the knowledge provided by their engineering qualification, supported by an ability to explain end user benefits. This is a niche skillset that will be highly valued moving forward and creates additional jobs for engineers and other technically minded individuals.

Increase in the use of technology through digitisation and automation, in the manufacturing process helps to reduce repetitive manual labour tasks, reducing work health and safety risks while improving product design accuracy and productivity. The use of industry 4.0 technologies also increases the services offering. An example of this is Wear plate sensing system.¹⁰ An organisation called Davies has developed a

² 'Australian Manufacturing Performance Report Australian Government Department of Industry, Science, Energy and Resources (Web Page 1 May 2020) <<https://www.industry.gov.au/publications/australian-manufacturing-performance-report#:~:text=Australia%27s%20manufacturing%20>>

³ 'Australian Industry Australian Bureau of Statistics (at ease 27 May 2022) <https://www.abs.gov.au/statistics/industry/industry-overview/australian-industry/2020-21>

⁴ 'Research and Experimental Development, Businesses, Australia Australian Bureau of Statistics (at ease 3 September 2021) <https://www.abs.gov.au/statistics/industry/technology-and-innovation/research-and-experimental-development-businesses-australia/at-ease>

⁵ *ibid*

⁶ 'Australian Universities Accord Discussion Paper: February 2023 <<https://www.education.gov.au/australian-universities-accord/resources/australian-universities-accord-pane-discussion-paper>>

⁷ *ibid*

⁸ 'Manufacturing competitiveness plan 2022: Transforming Australia from lucky to smart Advanced Manufacturing Growth Centre Ltd (accessed 13 March 2023) https://www.amgc.org.au/wp-content/uploads/2022/04/AMGC-Manufacturing-Competitiveness-Plan_2022.pdf

⁹ To find out more about Servitisation: Nico Adams 'Technologies and tools for manufacturing transformation: how to approach Industry 4.0 AU Manufacturing <<https://www.aumanufacturing.com.au/technologies-and-tools-for-a-manufacturing-transformation-how-to-approach-industry-4-0-by-nico-adams>>

¹⁰ 'Wear Plate Sensing System Advanced Manufacturing Growth Centre (Web Page 12 March 2020) <<https://www.amgc.org.au/project/wear-plate-sensing-system/>>

wear sensing system (WearSense) that captures live measurement data, such as: wear, temperature and vibration of wear plates. Wear Plate Maintenance is a major element of the operating costs of all global mining operators. WearSense enables real time condition-based wear management that improves productivity, safety and profitability and replaces manual procedures for measuring wear plate degradation.¹¹ This is an example of how a new business model can be developed using the advanced manufacturing process to solve current problems and improve the manufacturing process. The use of this data can lead to the company reducing the amount of wear plates required to keep on stock as they have real time information on what needs to be replaced and when. This reduces the traditional cost of production. Greater use of technology and innovative thinking opens more doors to increase trade intensity and exports, which generate new revenue streams.

In addition, new technological developments such as Artificial Intelligence (AI) and its integration into the manufacturing process need to be considered. This technology is allowing for greater, real time data analysis and process optimisation. Australia needs to be ready for, and agile enough, to integrate rapidly developing technologies into our processes to remain competitive. Industrial engineers and systems engineers are critical to this.

International trends in advanced manufacturing.

The discussions around sovereign capability and local manufacturing is not unique to Australia. Supply chain disruptions due to the global pandemic and geopolitical tensions, have highlight the need for other countries to considering their own manufacturing capability. This is particularly the case for critical components such as semiconductors and silicon chips. While this has some benefit to Australia through diversifying supply chains, particularly in engineering disciplines associated with developing downstream processing and value adding of rare earths and other critical minerals. It may negatively affect Australia's overall manufacturing capability due to an increase demand for manufacturing skills globally. Around 60 per cent of engineers in Australia are born overseas, making Australia highly reliant on migration for our engineering skills. With more of a global focus on manufacturing capability, Australia may not be able to rely on international skills to fill the gaps we have locally. This should be a call to action for the manufacturing industry to engage more closely with the tertiary sector to ensure the correct volume and calibre of locally trained engineers are delivered into the market demand.

The use of artificial intelligence is becoming more prevalent in the manufacturing process, particularly in its ability to analyse data from smart sensors and use that to make critical predictions, helping to increase productivity and lessen waste.

Competitive strengths and advantages of Australia in advanced manufacturing, including Australia's comparative international position in advanced manufacturing.

Industry 4.0 and advance manufacturing will provide Australia a competitive advantage in the manufacturing of niche products. The principles of advanced manufacturing and industry 4.0, which are essentially to bring production closer to the end user, will increase productivity in the sector, offset waste on the supply chain due to reduced input costs balancing higher wages and will open opportunities to move up the value chain. This also provides the added benefit of reducing carbon emissions. Engineers Australia's submission to the Department of Industry, Science and Resources on the [National Battery Strategy](#) highlights how Australia can move up the value chain thanks to our abundance of raw materials and the advantages our expertise in mining affords. An example of this is by engaging in minerals processing which could lead to manufacturing of niche products thanks to the advantages of industry 4.0 and advance manufacturing principles.

In 2016, the CSIRO released the Advanced manufacturing road map¹² which provides a good overview of the sector in Australia, including the comparative advantages. These include, our higher education and research institutions, our reputation for quality, safety and reliability, our small, medium enterprises as

¹¹ 'Wear Plate Sensing System' *Advanced Manufacturing Growth Centre* (Web Page 12 March 2020) <<https://www.amgc.org.au/project/wear-plate-sensing-system/>>

¹² 'Advanced manufacturing: A roadmap for unlocking future growth opportunities for Australia' CSIRO (November 2016) <https://www.csiro.au/en/work-with-us/industries/manufacturing/advanced-manufacturing-roadmap>

well as our natural resources. The competitive advantages outlined in this report are still relevant today. It is recommended the committee review this paper when considering the countries strengths.

Barriers to the growth of advanced manufacturing in Australia – including barriers to existing manufacturers, particularly small and medium enterprises, adopting advanced manufacturing technologies and processes such as AI and robotics.

The main barriers to advanced manufacturing capability in Australia have been identified by the Advanced Manufacturing Growth Centre. These include:

- traditional manufacturers not knowing the benefits provided by industry 4.0;
- limited support for firms wanting to deploy advanced manufacturing strategies; and
- a lack of a digitally skilled workforce.

Embracing digital technologies in manufacturing is critical to remain internationally competitive. The most successful manufacturing companies will need to adopt a combination of advanced knowledge, advanced processes and/or advanced business models to remain competitive.

Manufacturers in Australia face further barriers in their ability to transport manufactured goods to the end user locations. This is particularly the case for manufacturing of oversized products. Local industry often competes with international businesses who can manufacture or fabricate products overseas and ship them direct to clients in areas such as the Western Australian Pilbara more easily, and with less transport costs, than locally made products.

This highlights the criticality of a connected transport system which meets the needs of industry. For Australia to develop and maintain a manufacturing industry, particularly of oversize products, it needs to have the infrastructure to transport these products. This requires long-term planning and the protection of key high-wide load corridors to provide more efficient freight routes.

Financial and non-financial investment opportunities or possible reforms to support the growth of advanced manufacturing in Australia in: renewables and low emission technology; medical science; transport; value adding in agriculture, forestry and fisheries; value adding in resources; defence; and enabling capabilities.

Investments need to be made to upskill the Australian workforce in the areas which are critical to advanced manufacturing. With the engineering profession a critical component of the advanced manufacturing and industry 4.0 workforce, the government needs to consider ways to strengthen the STEM workforce in Australia.

Since 2014, engineering commencements in higher education has been declining. Engineers Australia has identified five categories of factors which influence the engineering profession in Australia. It is recommended committee review Engineers Australia's [Strengthening the engineering workforce](#) report. This report includes recommendations to government, industry and the tertiary sector to help increase those studying STEM subjects at school, increase the uptake of engineering studies in higher education and retain engineers in the profession.

Government should also look at investments which can support the broad uptake of digital engineering tools and innovations. The use of new technology, such as augmented reality, digital twins, smart sensors, digital engineering, and digital asset management tools, will ensure Australia is future ready. Governments must allocate funding for training and upskilling the labour force and subsidise programs to

promote collaboration between industry and academia to encourage greater integration of current and emerging technologies.

Supporting Australian innovation is also a key component of this conversation. Australia is a chronic underperformer when it comes to the commercialisation of engineering innovation. When innovation does occur, it is often not commercialised domestically which results in jobs and opportunities going offshore. An example of this is wi-fi. Wi-fi was developed in Australia, however, predominately commercialised abroad, taking the resulting jobs, companies and benefits of this breakthrough with it. Wi-fi is a critical component of industry 4.0 as it allows for connectivity of the devices which can enhance advanced manufacturing. Another example is Google maps, the software of which was developed in Australia, yet sold offshore in 2003.¹³ Engineers Australia's [Commercialisation of engineering innovation](#) directions paper outlines recommendations for increasing Australia's innovation capability through greater cooperation in the sector, grants and tendering process and tax and regulation reform.

An additional barrier in some parts of the manufacturing sector is a mindset of preferring to do things the way they have been done, rather than invest in iterative improvements to the manufacturing process to achieve global best practice. A mindset of continuous improvement needs to be fostered within the sector, with businesses wanting to improve because they see the benefits, rather than relying on governments grants and other support to upgrade plants and processes. Any government support programs should focus on the benefits to the business from embracing advanced manufacturing as well as financial support.

The Government's existing Entrepreneurs Program¹⁴ is a good example of a successful government program helping to develop Australia's manufacturing and innovation. The objective of the program is to connect small, medium-sized enterprises (SMEs) with the capabilities and networks needed to grow, innovate and commercialise in Australian and overseas markets.¹⁵ This program provides benefits in coupling grants with strategic advice on advanced manufacturing best practise and tactical growth facilitation. SMEs are a critical component to Australia's economy as they create jobs and increase innovation. By supporting these businesses through a program which provides strategic advice and expertise from an advanced manufacturing expert, learning and development events and grant funding, will continue to help develop Australia's advanced manufacturing sector. The Australian Government business website provides multiple examples of the success of this program.

Consideration should also be given to leveraging public/private partnerships in specific critical industries such as energy, agriculture, transport, communications and microchips, to assist in developing Australia's capability and shoring up supply chains.

The opportunities to increase the number of workers employed in advanced manufacturing, including consideration of ways to increase the participation and retention of women and other historically underrepresented groups.

Overcoming the diversity challenges is critical to alleviating current and future skills shortages and enhancing productivity and innovation by bringing in fresh perspectives and experiences to solve complex problems. Engineers Australia has commissioned two ground-breaking pieces of research which explore the diversity challenges around women choosing a career in STEM and the challenges facing migrant engineers in Australia. Engineers Australia recommends the following two papers be reviewed.

- [Barriers to Employment for Migrant Engineers](#)
- [Women in Engineering Research.](#)

The critical components in these pieces of research focus on:

¹³ 'How Sydney techies created Google Maps' *The Sydney Morning Herald* (19 October 2010) <https://www.smh.com.au/national/how-sydney-techies-created-google-maps-20101019-16smn.htm>

¹⁴ 'Entrepreneurs Program' *Australian Government* (accessed 16 March 2023) <https://business.gov.au/grants-and-programs/entrepreneurs-programme>

¹⁵ 'Entrepreneurs Programme – Program Guidelines: Version 12' *Australian Government Department of Industry, Science, Energy and Resources* (July 2020) <file:///C:/Users/mbe/Downloads/Entrepreneurs%20Programme%20Guidelines%20PDF.pdf>

- Promoting STEM in schools to build greater awareness of the profession.
- Greater support to retaining engineers in the profession.
- A focus of upskilling of existing staff and training to assist engineer re-enter the workforce after a career break.
- Programs to assist overcoming barriers to employment for migrants.

Skills needs in advanced manufacturing.

Industry 4.0 technologies provide the opportunity for new ways to capture and create value through combining technology with the standard manufacturing process. Advanced manufacturing has led to a reduction in the labour-intensive aspects of traditional manufacturing. As manufactures make this transition, employee characteristics of creativity and decisions making will be highly valued along with STEM skills.

The engineering profession will play a vital role in capitalising on the opportunities of Industry 4.0. We have seen Swinburne University create a post-graduate course which will equip engineers with the skills they need to lead the transition to Industry 4.0.¹⁶ This course will bring together manufacturing with computer science to prepare engineers for a design led digital future and the enabling technologies already available. These technologies include sensor and data analytics; advanced materials; smart robots and automation; and additive manufacturing.¹⁷

One of the difficulties in upskilling employees in these technologies are they are subject to rapid change. In addition to universities taking the lead in post-graduate courses, micro-credentialing could provide an opportunity for engineers to rapidly upskill in areas of industry 4.0 that are relevant and fast developing. This would negate the need for engineers to invest heavily (in both time and money) learning about technology that is rapidly evolving and allows for cross skilling, helping bring engineers from different disciplines to knowing about advanced manufacturing.

Developing Australia's domestic capability in digital technologies is a must. Literacy in STEM is fundamental. For niche areas or developing technologies, the key is to identify the areas of specialisation first. Then look at the skills and resource requirements which will be needed to upskill or reskill the workforce.

¹⁶ 'How Engineers can take charge of Industry 4.0 *Create Digital* (Web Page 11 November 2020)
<https://www.createdigital.org.au/engineers-take-charge-industry4_0/>

¹⁷ Sometimes referred to as 3D printing

