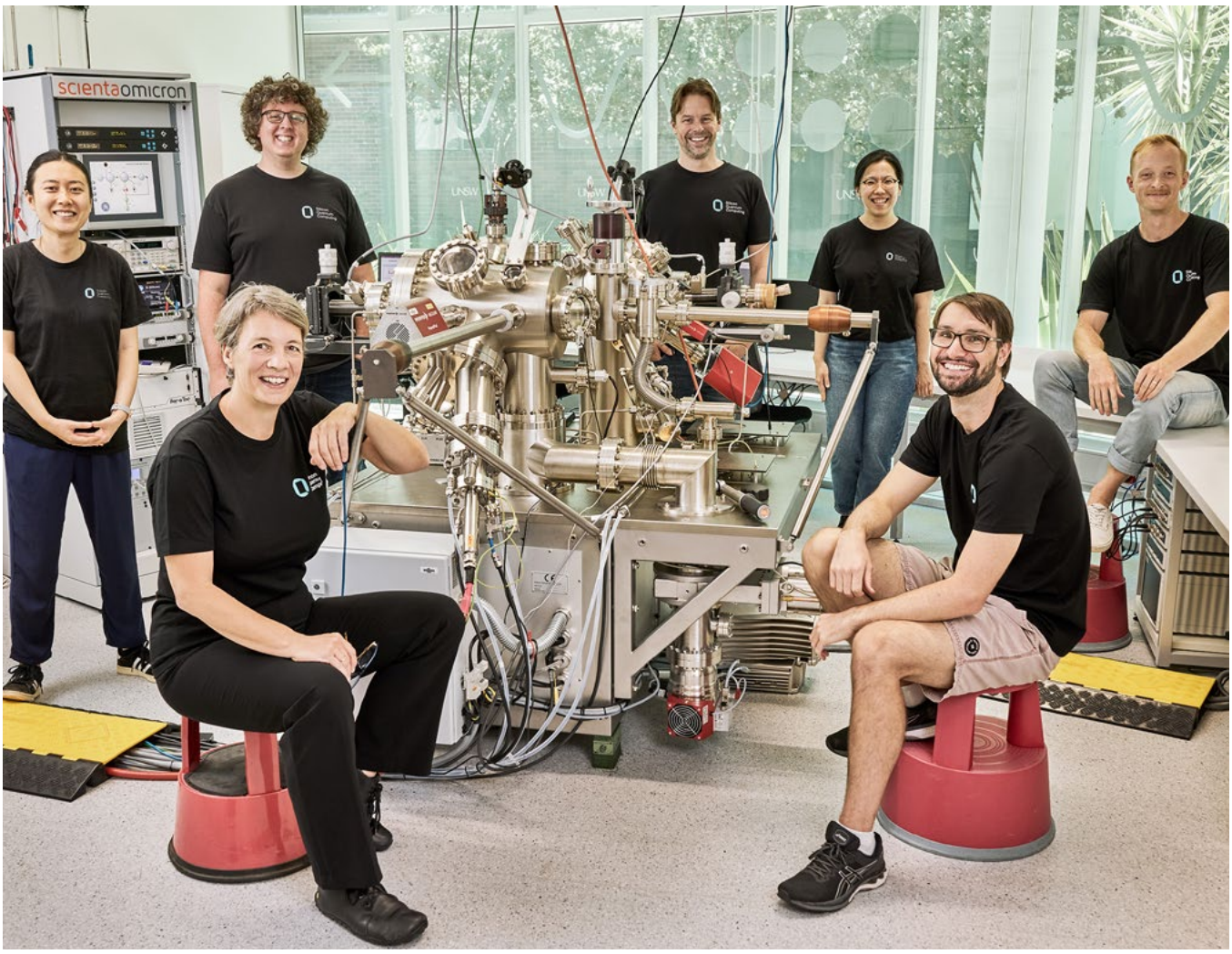
Making it in NSW

Time for action | July 2022

Modern Manufacturing at Cochlear, NSW



Professor Michelle Simmons and team at the discovery and manufacture of an atomic scale integrated circuit.

Acknowledgement of Country

The Modern Manufacturing Taskforce acknowledges that Aboriginal and Torres Strait Islander peoples are the First Peoples and Traditional Custodians of Australia, and recognises their continued custodianship of Country — land, seas and skies. We acknowledge the diversity of First Nations cultures, histories, and peoples, recognise their enduring connection to our state, and we pay our deepest respects to Elders past, present and emerging.

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1 About the NSW Modern Manufacturing Taskforce

About the Modern Manufacturing Taskforce

In December 2021, the NSW Premier announced the intention to appoint a Modern Manufacturing Commissioner whose role will be to identify local research and ideas that can be transformed into new opportunities, while removing barriers to support the growth of advanced manufacturing in NSW.

The work of the Modern Manufacturing Commissioner will be spearheaded by a Taskforce led by Mr Anthony Shepherd AO. The Taskforce's members have been selected from prominent, NSW-based manufacturing experts from a range of backgrounds, including the CEOs of some of NSW's most successful manufacturing businesses, through to industry bodies and academia.

Members of the Taskforce are:

- Dr Bronwyn Evans AM – CEO, Engineers Australia
- Professor Roy Green – Special Innovation Adviser, University of Technology Sydney
- Dig Howitt – CEO and President, Cochlear Limited
- Chris Jenkins – Country Director and CEO, Thales Australia

The Taskforce was appointed and got underway on 1 April 2022, completing its review and signing off on the Report on 28 July 2022. This was a remarkably short time period in which to consult a wide range of people and bodies and produce a detailed Report.

As Chair, I would like to thank my fellow Members of the Taskforce for their availability and outstanding contribution. However, this would not have been possible without the outstanding performance and support of Ms Kylie Bell, Managing Director, Investment NSW, and her Secretariat under the leadership of Dr Darren Bell, Associate Director, Investment NSW, and including Mr Paul Clark, Associate Director, Investment NSW, and Mr Li Chen, Associate, Investment NSW.

This is an independent report developed by the Taskforce, consistent with its Terms of Reference, and does not constitute NSW Government policy.

About the Chair

Anthony F Shepherd, AO

Tony is Chairman of Venues NSW, the AFL GWS Giants, Bingo Industries Pty Ltd and the Inaugural Chairman of Infrastructure SA. He is also a Director of Racing NSW, Enviropacific Pty Ltd, Virgin Australia International Holdings Limited and Snowy Hydro Limited.

Tony has had an extensive career in Australia and overseas in the private and public sectors, mainly in infrastructure and engineering. He pioneered private infrastructure with projects such as the Sydney Harbour Tunnel, Melbourne City Link and East Link. He was the inaugural Chairman of WestConnex. He oversaw the listing of Transurban, Transfield Services and Connect East.

In his early public service career, he was involved in defence procurement and research and development, including three years in the United States. At Transfield he was Bid Director for the successful Anzac Warships bid. The project delivered 80 per cent of local content and was delivered on time and budget. He was also a Director of Australian Defence Industries.

Tony was President of the Business Council of Australia and Chairman of the National Commission of Audit.

He is a Member of the Australian Institute of Company Directors and a Patron of Infrastructure Partnerships Australia.

In June 2012, Tony was named as an Officer of the Order of Australia.

About the Members

Dr Bronwyn Evans AM

Dr Bronwyn Evans AM is the Chair of Building4.0 CRC, a Director of Standard Communications (GME) and a Director of listed medical device company EBR Systems Inc (ASX EBR). She chairs the NSW Bushfire Mission Expert Panel.

She recently held the position of CEO of Engineers Australia, and has led innovation initiatives as Chair of the Growth Centre for MedTech and Pharmaceuticals and as a member of the Industry4.0 Advanced Manufacturing Leadership group.

Dr Evans has 40 years' experience in engineering, including at Cochlear and GE Healthcare. She has an Honorary Doctorate from Swinburne University, is an Honorary Fellow of the University of Wollongong and Engineers Australia and a Fellow of the Australian Academy of Technological Sciences and Engineering. In 2021, she was named Woman of the Year at the Women in Industry Awards and has been recognised as one of Australia's 100 most influential engineers and recognised as one of 100 Women of Influence.

Professor Roy Green BA LLB (Adelaide) PhD (Cambridge)

Roy is Emeritus Professor and Special Innovation Adviser at the University of Technology Sydney, where he was Dean of the UTS Business School.

His undergraduate degrees are from the University of Adelaide, and he has a PhD in Economics from the University of Cambridge.

He has published widely in the areas of innovation, industry, and regional development policy, including projects with the OECD and European Commission.

Roy chaired the Australian Government's Innovative Regions Centre, CSIRO Manufacturing Sector Advisory Council, NSW Manufacturing Industries Advisory Council and Queensland Competition Authority.

Currently, he chairs the Advanced Robotics for Manufacturing Hub and Port of Newcastle, and he is a director of the Innovative Manufacturing CRC.

Dig Howitt

Dig Howitt was appointed Chief Executive Officer and President of Cochlear Limited in January 2018.

Dig joined Cochlear in 2000 and has held several positions within the company. He started in the role of Engineering Manager in Product Development. He was then Senior Vice President, Manufacturing and Logistics from 2002-2014, President Asia Pacific from 2014-2016 and Chief Operating Officer from 2016-2017. Dig was appointed President in July 2017.

Prior to joining Cochlear, Dig worked as a consultant for the Boston Consulting Group and held general management positions in Boral and Sunstate Cement. Dig is a member of the Champions of Change Coalition STEM Group.

Dig holds a Bachelor of Engineering (Hons) in Electrical Engineering from the University of Sydney and a Master of Business Administration from Stanford University in the United States.

Dig is married to Kate, and they have a son and daughter. He swims to keep fit.

Chris Jenkins

Chris Jenkins is a defence industry leader, a passionate believer in local skills, and a strong advocate for Australian engineering, technology, design and manufacturing.

Focusing on delivering performance advantages for major defence and infrastructure customers, he has played a crucial role in transforming the company from five separate businesses into one of Australia's largest suppliers and exporters of mission-critical products and services.

Chris has held senior roles in Thales locally and internationally for over 30 years. He was appointed as Thales Australia CEO in January 2008, following the company's 100 per cent acquisition of the Australian Defence Industries (ADI) joint venture in 2006.

He is currently National President of the Australian Industry Group and member of the AIG Defence Council and a former Non-Executive Director in Naval Group Australia. He has a longstanding involvement in large-scale projects in critical industry sectors and was previously Chairman of the International Centre for Complex Project Management, as well as a member of the Defence Portfolio Ministerial Advisory Council and the DSTO Advisory Board, and an Advisory Board member of the Centre for Defence Industry Capability.

Chris is an Honorary Fellow of the AIPM, a Fellow of Engineers Australia, a Patron of RUSI NSW, and an Adjunct Professor of the University of NSW. In 2013, he received the Insignia of Knight in the French National Order of the Legion of Honour.

2 Foreword

A message from the NSW Modern Manufacturing Taskforce

Manufacturing in Australia is at a critical juncture. The end of Australian car production in 2017 heralded, for some, the end of Australia's manufacturing history. Certainly, many factories utilising machinery and techniques from an earlier age are now closed and will not reopen.

NSW manufacturing has been in decline for many decades. Manufacturing growth on an Annual Average Growth Rate (AAGR) basis is the lowest of all industries over the 20 years to 2020-21 at -0.6 per cent, and third lowest in the last 10 years. While over the last five years NSW manufacturing industry AAGR has been positive at 0.4 per cent, it still lags behind many other industries.

In fact, manufacturing in NSW has gradually lost Industry Gross Value Added (IVA) share of the national total over the last 30 years, mainly to Queensland (which has increased its share of IVA from 12.9 per cent to 19.3 per cent share) and Western Australia (which has increased its share of IVA from 8.9 per cent to 13.3 per cent share) – although they are coming from a low manufacturing and economic base. In recent years, this downward trend in NSW has stabilised. NSW remains the largest manufacturing state in Australia based on IVA, but only sits just above Victoria (Australian Bureau of Statistics, 2022).

A similar situation is observed when comparing manufacturing as a percentage of GDP / GSP to other international jurisdictions. In 2021-22, Australia ranked last in the OECD (World Bank, 2022) with 6 per cent of GDP attributed to manufacturing (down from 11 per cent in 2002), compared to Singapore at 21 per cent, Germany at 18 per cent, Belgium at 13 per cent, Israel at 11 per cent, Canada at 10 per cent (2018 figures) and the United Kingdom at 9 per cent. For NSW, the percentage of manufacturing of GSP was 10 per cent in 2002, 7.6 per cent in 2012 and 5.8 per cent in 2021 (Australian Bureau of Statistics, 2021).

Similarly, Australian manufacturing productivity (as measured by Labour Productivity), has also continued to decline. Since 1990-91 manufacturing productivity has improved by 58.7 per cent, however, in the last decade, manufacturing productivity has only grown 5.8 per cent and is fifth lowest of all industry sectors in Australia. While the factors contributing to this are many, varied and complex, this is the overall primary reason to encourage and incentivise the adoption of modern manufacturing across NSW. Advanced processes, technologies, and knowledge are the main drivers for productivity improvements by modern manufacturers.

In 1985, the NSW manufacturing industry was the state's largest employer. In 2022, it ranks ninth largest and has followed a downward trajectory over time largely due to automation, offshoring / outsourcing, and a structural shift towards services (Australian Bureau of Statistics, 2022).

When it comes to exports, Australia has a narrow trade and industrial structure. Resources dominate, with agriculture and services much smaller and manufacturing a poor last. Investment in the diversification of our export base and increase in our economic complexity is needed to minimise Australia's

exposure to external factors, such as geopolitical and international supply chain impacts, and to increase our value-add on product development for an improved balance of trade.

These results represent a failure of successive governments at all levels to address the decline in manufacturing, and reflect business preference to outsource to cheaper labour jurisdictions at the cost of quality and sovereignty. It's now time to play catch up. While it will be costly, there are many opportunities that should be taken as they arise to arrest these declines and to benefit of the overall economy.

In addition to our decline in manufacturing, many external factors have had an impact since 2017. The war in Ukraine in 2022 and the immensely destructive COVID-19 pandemic have had multiple adverse affects, including supply chain disruption, exposing gaps in sovereign capability, and driving up energy prices. Yet, the pandemic also generated a renewed determination to innovate and rapidly produce solutions to pressing real world problems. An example is the rapid pivot by NSW company Ampcontrol **(see case study in Appendix 3)** to design and manufacture emergency ventilators in just 18 days (Ampcontrol, 2020). Across the world, collaboration between researchers, business and governments has driven innovative product development at an almost unprecedented rate.

In some ways, the pandemic response has utilised a largely unnoticed modern-day manufacturing agility that has existed in Australia for years. That agility was partly attributable to innovation and collaboration philosophies central to Industry 4.0, or 'the Fourth Industrial Revolution' (Kergroach, 2017). This is marked by interconnected and autonomous technologies that enable intelligent products, machines, networks and systems to independently communicate and cooperate with each other, with minimal human intervention. This Fourth Industrial Revolution is important as it offers not only broader opportunities to advance technology and improved productivity, but also to reduce waste and enhance lifestyle.

The Fourth Industrial Revolution, sometimes called 'Modern' or 'Advanced' manufacturing, represents an opportunity for Australia and for NSW. On one hand, Australia ranks low in terms of global manufacturing industry size and economic complexity; on the other, Australia hosts world-renowned research capabilities, highly ranked universities, and rapidly growing innovation ecosystems. These are some of the elements that a modern manufacturing capability requires. The other elements include investment and government involvement to catalyse development.

In a country with a small domestic market (0.3 per cent global population and 1.4 per cent global GDP) and one of the world's highest labour costs, to be viable a manufacturing business requires being globally competitive in price, performance, and customer satisfaction. International examples, such as Flanders Make and the Fraunhofer philosophy of ***better not cheaper***, show that this is possible and sustainable.

To grow manufacturing in NSW we need to build on our strengths and focus on specialised, niche capabilities and products that have a global market demand. This will enable NSW manufacturing to scale and be globally competitive. NSW is still the largest manufacturing state within Australia and home to a range of successful, innovative domestic and international companies that have followed this approach; making and exporting world-leading products. Examples include GME, Cochlear, Thales Australia, BlueScope, Quickstep and Nanosonics.

Only business can grow NSW manufacturing, but it requires a whole-of-government approach underpinned by a strategic vision and an unwavering, focused and long-term commitment to help it develop. This will only be effective if the environment is attractive and sustaining to business.

The Modern Manufacturing Taskforce commends this vision to the NSW Government:

> ***Grow the economy of NSW and Australia by reinstating manufacturing as a major economic force, thus ensuring a reasonable level of domestic self-sufficiency in the supply of, and local support for, critical equipment, materials, and supplies, diversifying our exports and generally raising the prosperity of all Australians.***

There are strong similarities now to where we were after the Second World War when, based on the harsh experience of the war, we embarked on growing our industrial, R&D (including defence and space) and infrastructure base.

Manufacturing and engineering make our society smarter, more secure, fairer, and more prosperous. Manufacturing is a horizontal capability and not a stand-alone business sector. It is an essential part in the whole business economic ecosystem. Manufacturing transforms Australia's abundant natural resources into valuable goods; capitalises on intensive research and development, innovation, and investment; and generates challenging, high value, gender neutral services jobs throughout the value chain. Australia and NSW have missed many of the value adding opportunities that can be derived from our natural resources by sending raw materials overseas to countries that then benefit from high value-adding through modern manufacturing processes. A revitalised NSW manufacturing sector will leverage our world class research and expand its capabilities into value-adding post resource extraction.

What is Modern Manufacturing?

'Modern' manufacturing is not only concerned with what is being produced, but how it is being produced, including activities that make an organisation internationally competitive. Modern manufacturing techniques are applicable across multiple sectors. Resources, food and beverages, medical devices, fabrication, steel and other metals production, and more, all offering similar opportunities to develop, adopt, and employ Industry 4.0 capabilities across these sectors. The hallmarks of Industry 4.0, or modern manufacturing, include advanced knowledge, process and skills, advanced business models, sustainability, high productivity, and customer satisfaction.

A strong and diverse modern manufacturing capability will provide NSW and Australia with realistic opportunities to meet community expectations for a cleaner environment and a less wasteful economy. NSW has significant opportunities in this space, including in green energy production, recycling and other elements of the circular economy. Indeed, the transition out of a carbon-based economy can only be achieved through modern manufacturing.

To capitalise on NSW's advantages with abundant natural resources, world-class research capability, high levels of education, a globally favourable position across multiple emerging technologies (McFarland, et al., 2022), first-class infrastructure and connectivity, and low sovereign risk will require the expansion of

the already established regional hubs and special activation precincts. This model of sector specialisation and collaborative sharing of expertise and resources, creating pockets of high-tech modern manufacturing trailblazers, has shown to work – but more needs to be done to expand these pockets and effectively connect them together into a modern, growing, and highly internationally competitive manufacturing capability.

The Taskforce applauds the establishment of the Advanced Manufacturing Research Facility (AMRF) where talent, investment, and infrastructure come together in shared facilities. The AMRF offers smaller businesses the opportunity to turn ideas into true commercial prospects by offering them the cutting-edge tools and expertise that are needed. Broadening the AMRF model across the state along the lines of the UK Catapult model is expected to provide the catalyst for modern manufacturing hubs to grow and for the creation of high skilled jobs.

The NSW Government has recognised the importance of modern manufacturing and is in the process of appointing a Modern Manufacturing Commissioner to revitalise, champion, and chaperone the implementation of a new NSW Advanced Manufacturing Strategy. This report aims to provide candid, frank and honest advice to the NSW Government and for the new Modern Manufacturing Commissioner, with concrete and actionable recommendations. It is essential the Commissioner has the support, expertise, and authority to execute this vital role.

The recommendations provided in this report have been developed through extensive consultation, research, and considered reflection. **The Modern Manufacturing Taskforce recommendations form an integrated approach to achieve their desired outcomes** as they are not all standalone. Many leverage each other in joint implementation.

The tasks before the Modern Manufacturing Commissioner will not be easy. Yet, with resolve and commitment, we can support our manufacturers to further modernise, increase their international competitiveness, grow sophistication, and develop the tools and capability to decarbonise our economy – resulting in a more prosperous, fair, sustainable, and secure society.

The Taskforce would like to thank the many businesses, individuals, research organisations, industry associations and government representatives (at all levels), for freely giving their valuable time and support for the development of this report **(see Acknowledgement)**. It could not have been developed without them.

We commend the report to you.

3 Executive summary

Overview

Manufacturing in Australia is at a critical juncture. On the one hand, Australia ranks last in terms of manufacturing self-sufficiency and economic complexity in the OECD (Australia Parliament Senate Economics References Committee, 2022). On the other hand, NSW is still the largest manufacturing state within Australia, and home to a range of innovative companies that make and export world-leading products (Australian Bureau of Statistics, 2022).

To put the decline of Manufacturing in NSW into context, its growth on an Annual Average Growth Rate (AAGR) basis is the lowest of all industries over the 20 years to 2020-21 at -0.6 per cent, and third lowest in the last 10 years. Services have recorded the strongest growth rates over the last two decades, reflecting the experience of most advanced economies as consumers' wealth and incomes grow. NSW manufacturing industry AAGR over the last 5 years has been positive, at 0.4 per cent, but still lags behind many other industries.

To reverse these trends, we need to look to modern manufacturing. Due to higher input and export costs compared to our international competitors, NSW cannot compete internationally on price, and must adopt the *Fraunhofer and Flanders Make* philosophy of **better not cheaper**. NSW has significant ongoing examples of this philosophy in action: international breakthroughs in Quantum Computing, Medtech, Biotech, Agritech, Green Steel, and so on.

The NSW Government previously released the 2018 NSW Advanced Manufacturing Industry Development Strategy. The Strategy served as a focus for setting solid foundations for the future of manufacturing in NSW, however, it was unfunded and lacked the capacity to deliver any game-changing impact.

The NSW Government has recognised the importance of modern manufacturing and is in the process of appointing a Modern Manufacturing Commissioner to revitalise manufacturing in NSW. This report supports that work. In addition, the NSW Government has recently released its Industry Development Framework ('The Framework') (Centre for Economic and Regional Development, 2022). Its vision is to create a business environment conducive to economic growth and social prosperity through industry policy. The Framework will complement existing policies by consistently identifying the right levers for government to use in selected situations, thereby effectively increasing incentives for firms to innovate, scale and boost productivity. This report's themes and recommendations are aligned to this Framework.

The Taskforce recommends the creation of a new, updated Modern Manufacturing Strategy. In broad strokes, the updated Strategy should be based upon the following principles:

- Focus on current and potential state strengths, with reference to the NSW Industry Development Framework, the Industry Development Policy (Securing Future Innovation and Global Competitiveness in NSW) and the NSW R&D Roadmap.
- Develop clear and consistent policy goals for the revitalisation of manufacturing in the context of a long-term approach to programs and funding, in close alignment with the Commonwealth's evolving priorities and delivery mechanisms.
- Ensure regular annual monitoring and evaluation of programs to measure their effectiveness in boosting productivity, creating the high-skill jobs of the future and building a competitive and dynamic knowledge-driven economy.

Definitions

Modern manufacturing is a key feature of advanced knowledge-based economies and considered to be part of Industry 4.0 transformations. Modern manufacturing is not only concerned with what is being produced, but how it is being produced, including activities that make an organisation internationally competitive. Artificial Intelligence, the Internet of Things (IoT), cyber-physical systems (CPS), cloud computing and automation have all contributed to modern or advanced manufacturing. Those terms will be used interchangeably in this report.

In light of Industry 4.0, our definition is that 'modern manufacturing' should be considered as a capability, and not limited to any particular sector. It is a horizontal capability and not a stand-alone business sector; applicable across multiple industries, such as agribusiness, clean energy, defence and more. Furthermore, modern manufacturing is characterised by the below features:

- Advanced knowledge, processes, and or/skills, advanced business models – usually globalised
- High productivity, high skilled jobs
- Creating products that fulfil previously unmet needs
- Connectivity and/or use of big data
- Collaboration with researchers
- Automation, advanced materials or otherwise advanced technology

There appears to be broad agreement that 'advanced' or 'modern' manufacturing is concerned with technologically advanced products and/or products made using technologically advanced or otherwise innovative means. 'Advanced' or 'modern' manufacturing is sector-agnostic but there is a general expectation that it should be globally competitive, meeting a market need, and be efficient and profitable (or developing in that direction).

Appropriate roles for Government

As a relatively small nation by population, Australia and NSW need to focus on aggressively exploiting our competitive advantages and identifying and onshoring our critical supply chains. At the same time, we must overcome our disadvantages, such as high labour costs and a comparatively higher corporate tax rate by OECD standards.

The Commonwealth has established a list of national priorities by theme, which NSW can align to. NSW can use its autonomy to either drill down or include sideways options into its own focus priorities. This will help on three fronts:

1 **To align NSW more strongly with the Commonwealth, thereby placing NSW in a better position to access Commonwealth funding**

2 **To provide a collaborative, national approach to manufacturing that supports the development of niche capabilities where they are best and most logically located, avoiding overlap across states which reduces our capacity to scale and compete economically.**

3 **To provide incentives such as grants, co-investment, low interest loans, tax relief, provision of infrastructure, procurement etc.**

It is acknowledged that much has already been started by both the Commonwealth and NSW Governments, such as changes to the Patent Box regime (with more changes on the way) which helps to make corporate tax competitive, but there is much more to do.

- Policies and initiatives **must** be long term and preferably legislated, as this is essential to giving business the confidence to invest. Long-term political stability, policy consistency and bipartisan buy-in at both the Commonwealth and the State level are needed to establish and shore up business confidence. Such initiatives have worked in other jurisdictions. International examples include the UK Catapult system, Flanders Make in Belgium, and Singapore's business-friendly suite of initiatives.
- The plethora of programs should be rationalised, by simplifying, consolidating and sufficiently funding to allow them to scale. Establishing a Concierge service will help businesses find their way through the many state and Commonwealth Government programs and grants, and shepherd them through difficult government services such as planning, procurement, education and training, and regulation. Targeted business support programs should make greater and more creative use of the policy levers at the disposal of the NSW Government.
- Support is required for structured collaboration between industry and research institutions through industry-led research and technology, rather than the traditional linear lab to market. That old approach worked up to a point in the days of large companies like IBM, Bell Labs, and Xerox – with significant in-house laboratories combined with blue sky research and extremely well resourced from Defence Advanced Research Projects Agency (DARPA) and top universities. However, the in-house R&D model has now been superseded with new collaborations and research focus needs to be industry-led.

- Modern manufacturing should be promoted as a clean, exciting, high-tech career, dispelling old images of dirty, unskilled, noisy, assembly line type activities.
- Public procurement should be better leveraged to support local manufacturing and innovation; contracts need to update calculus to include the impacts on local manufacturing in the 'value for money' considerations. A contract is better than a grant and brings with it prestige and uplift in reputation to the manufacturer.
- Cooperation should be enhanced and cost-effective integration encouraged, where appropriate, of state and Commonwealth industry programs. This will avoid sub-scale duplication and fragmented efforts, as well as nurturing cooperation on much bigger, national, opportunities such as safely and cost effectively managing the transition to decarbonisation through the application of technology.
- An approach from Commonwealth and NSW Governments should be coordinated, to leverage industry support for skills and training through a three-tiered approach: looking at short term solutions through urgent reactivation of the skilled migration program, with increased numbers of skilled worker visas and a streamlined approval process; considering medium term enhancements through more integrated university-VET pathways and industry placements, supporting the development of local training; and investing longer term through better STEM preparation in schools.

Themes for areas of focus

The key is to focus on challenging, high value, gender neutral services jobs and technologies that can thrive in a high-cost base environment. This includes operating highly automated pieces of equipment.

This means we must embrace Modern Manufacturing to be smarter, better, and more productive – not cheaper. The research and consultations conducted for this report identified the following focus areas:

- **Coordinated approach:** the appointment of the Modern Manufacturing Commissioner provides a unique opportunity to engage in a coordinated approach to priority setting, program implementation and cultural change through an activist industry-facing role. The Commissioner must be adequately empowered and resourced to carry out the task of growing NSW's manufacturing sector. At the same time, the Commissioner should also build on the foundation of previous work and strategies, and champion the cause of manufacturing in relevant regulations and legislation.
- **Collaboration:** impact will only come from close consultation and collaboration with industry. There are many seminars and conferences etc., but we have seen examples where the Government has not fully leveraged these. The Modern Manufacturing Commissioner has a role to play in this coordination, which should be more structured and automatic. The NSW Government must help deepen collaboration between researchers and manufacturers, with a focus on industry-led research and technology that provides a problem looking for a solution (pull commercialisation). This should supersede the traditional linear lab to market approach, which represents a solution looking for a problem (push commercialisation).

- Examples and best practices from Belgium and the UK should serve as a model for NSW to emulate. The Advanced Manufacturing Research Facility (AMRF) is a first step towards deeper collaboration and the Government should support its operations on a long-term basis, extending it into regional nodes.
- **Promotion:** manufacturing has suffered from an image problem that is a hangover from the past. The Commissioner must change the perception of manufacturing, promoting it to the public by leveraging industry associations and their networks. Modern manufacturing is new, clean, skilled, and incredibly technologically advanced. By actively promoting the modern image of manufacturing, it would increase the appeal of manufacturing jobs and bolster the talent pool in the longer term. Promotion of new entrepreneurial ventures is also a must, and the Commissioner should be involved in the development of the various innovation precincts, building on NSW competitive advantages in digital technologies, quantum computing, materials science, synthetic biology, artificial intelligence and data analytics.
- **Procurement:** procurement needs to be used to revitalise local manufacturers. Revisions must be made to NSW Government procurement policies so that the state manufacturing ecosystem is appropriately supported. Procurement and co-investment carry less risk to government, provide businesses with a highly respected customer, and ensure greater innovation in government solutions than grants.
- **Targeted business support:** the NSW Government must do more to support manufacturing businesses who are looking to grow. Existing programs should be reviewed and consolidated where possible; there should be a separate concierge/Customer Relations Manager service offered by the Office of the Modern Manufacturing Commissioner. The concierge service will serve the needs of all manufacturers in the state, from start-ups to established firms. NSW should also roll out Smart Industry Readiness Index (SIRI) tests for manufacturers seeking to modernise their business.
- **State/Commonwealth cooperation:** there is a suite of Commonwealth initiatives in place to encourage manufacturing, especially regarding supply chains. NSW must leverage those Commonwealth initiatives and secure Australia's interest at the same time, through onshoring production of essential goods, such as PPEs and semiconductors.
- **Skills and talent:** For the manufacturing sector to flourish in NSW, there must be a steady pipeline of skills and labour. The short-term solution is to issue more visas for overseas workers; the medium-term solution is to encourage university students and graduates to engage in manufacturing through industry placements; and the long-term solution is to encourage more students to take up STEM subjects in high school.

Focus themes aligned to NSW Industry Development Framework

No.	Theme	Industry Development Framework
1	Coordinated approach to priority setting, program implementation and cultural change through activist industry-facing role for the Modern Manufacturing Commissioner, with adequate resources and staffing.	Principles under the Framework: Transparent governance
2	Support for structured collaboration between industry and research institutions, including co-investment initiatives through a new network of Catapult-like Advanced Manufacturing Research Facility (AMRF) outreach facilities in key manufacturing centres around NSW.	Policy Target: Business Environment – Technology Policy Target: Business Environment – Financial capital
3	Promotion of new entrepreneurial ventures in innovation precincts, building on NSW's competitive advantages in digital technologies, materials science, quantum technologies, synthetic biology, artificial intelligence and data analytics.	Policy Target: Business Environment – Infrastructure (i.e. cluster models – precincts; standards for models of collaboration)
4	New approach to public procurement led by the Modern Manufacturing Commissioner to promote technological change and innovation, and local participation in major infrastructure projects, enabling creation of new high skill, high productivity jobs.	Policy Target: Business Environment – Domestic markets
5	Targeted business support programs in designated priority areas to build management and enterprise capability in global markets and value chains, with emphasis on enterprise absorptive capacity and circular economy.	Policy Target: Business Environment – Productive capacity
6	Enhanced cooperation and cost-effective integration, where appropriate, of state and Commonwealth industry programs to avoid sub-scale duplication and fragmented efforts, including in the challenge of knowledge-based Foreign Direct Investment (FDI) attraction.	Principles under the Framework – Coherence with policies in other levels of government
7	Coordinated program of government and industry support for skills and training through more integrated university -VET pathways, STEM preparation in schools and urgent reactivation of the skilled migration program.	Policy Target: Business Environment - Skills

NSW Government strategies that this report aligns to

- 2040 Economic Blueprint
- R&D Roadmap
- Critical Minerals Strategy
- NSW Trade Statement
- Net Zero Plan
- Precinct Strategies (Tech Central, Westmead, Special Activation Precincts)
- Industry Development Framework
- NSW Advanced Manufacturing Industry Development Strategy (2018)

Commonwealth Government strategies that this report aligns to

- Commonwealth Modern Manufacturing Initiative and the National Manufacturing Priorities:
  1. Resources Technology & Critical Minerals Processing
  2. Food & Beverage
  3. Medical Products
  4. Recycling & Clean Energy
  5. Defence
  6. Space
- Commonwealth Modern Manufacturing Strategy
- The Blueprint and Action Plan for Critical Technologies
- 2022 Critical Minerals Strategy
- Sovereign Manufacturing Capability Plan
- Department of Industry, Innovation and Science, National Quantum Strategy Issues Paper
- Long-Term Emissions Reduction Plan
- National Waste Policy Action Plan

4 List of recommendations by theme

1. Coordinated approach

The appointment of the Modern Manufacturing Commissioner provides a unique opportunity to engage in a coordinated approach to priority setting, program implementation, and cultural change through an activist industry-facing role. However, this will require a commitment to adequately resource and staff the Office of the Modern Manufacturing Commissioner.

Recommendations – Coordinated approach

No.	Recommendation	Implementation time frame	Impact realisation
1.1	That the Modern Manufacturing Commissioner's Office is properly resourced and staffed throughout the term, with manufacturing expertise to provide an overarching coordinated approach and to deliver on the recommendations from the Modern Manufacturing Taskforce. *[The Taskforce welcomes the decision by the NSW Government to extend the term of the Modern Manufacturing Commissioner to a minimum three-year term, and it is recommended that there be flexibility to extend the term]*	**Short term**	**Short term**
1.2	The Modern Manufacturing Commissioner must have the power to work across, and have influence on, all NSW government agencies and portfolios, as well as regular access to the Minister, whilst maintaining autonomy and representing NSW on state and Commonwealth committees (mimicking the Queensland Coordinator General powers).	**Short term**	**Medium term**
1.3	That the Modern Manufacturing Commissioner update the existing Advanced Manufacturing Industry Development Strategy (2018) by developing a new NSW Modern Manufacturing Strategy. The strategy should: • Focus on state strengths based on the NSW Industry Development Framework, the Industry Development Policy (Securing Future Innovation and Global Competitiveness in NSW), and the NSW R&D Roadmap • Align to the Commonwealth Manufacturing Statement and Priorities • Align policy aims and have a consistent and persistent approach to manufacturing in terms of longevity of programs and certainty of long-term funding (Flanders Make model) • Ensure annual evaluation of any programs developed to measure their effectiveness against the original goals and terminate ineffective programs in a timely fashion • Be sufficiently funded to achieve its stated program goals and objectives.	**Short term**	**Medium term**
1.4	That the NSW Government recognise the importance of local manufacturing across the entire Government, by imposing a requirement to consider the impact of legislation and regulation regarding industry on local manufacturing. For example, include a test as to whether the proposal would "promote or disadvantage local manufacturers" via the inclusion of an impact statement, from consultation. This includes, but is not limited to, anything concerning procurement, training, or planning.	**Short term**	**Medium term**

2. Collaboration

Develop, in collaboration with state-wide research and industry partners, structured co-investment initiatives through a new network of Catapult-like Advanced Manufacturing Research Facility (AMRF) outreach nodes (Hub and Spoke model) in key manufacturing centres around NSW.

Recommendations – Collaboration

No.	Recommendation	Implementation time frame	Impact realisation
2.1	That the NSW Government sustain its funding for the Advanced Manufacturing Research Facility (AMRF) beyond 2026 – this would provide ongoing capability-building, certainty to industry and increased NSW competitive advantages, as well as contributing to attraction and retention of skilled labour.	**Short term**	**Long term**
2.2	That the NSW Government develop a UK Catapult type network across NSW (with the potential to expand across Australia in collaboration with the Commonwealth and other states and territories) by building on and linking to the AMRF, developing facilities and structures (Manufacturing Capability Centres) across the state which will deepen the impact of the AMRF across NSW (and eventually Australia). There should be at least six regional nodes – Manufacturing Capability Centres – in locations such as Newcastle and Wollongong, subject to the Modern Manufacturing Commissioner's recommendations. Each Manufacturing Capability Centre should be established by leveraging existing infrastructure and initiatives, such as the Melt and HunterNet, with enhanced linkages to higher education and industry (and to each other) and focus on R&D to solve industrial problems with commercial value, as well as training and reskilling functions. Regional NSW advised they can help fund the expansion of the AMRF model into the Manufacturing Capability Centres (regional hubs).	**Short term**	**Long term**

This initiative needs to link to relevant existing and proposed networks, to ensure they leverage each other and do not cause duplication.

It should also support increasing the percentage of Australian components into existing products to shore up critical supply chains. This is particularly important in the defence arena.

This replicated UK Catapult model should also be able to connect customers / stakeholders with experts in internationally recognised Industry 4.0 constructs such as:

- The World Economic Forum's Global Lighthouse Network
- The Smart Industry Readiness Index (SIRI) offered by the International Centre for Industrial Transformation (INCIT).

2.3

That the NSW Government sufficiently resource the Industry Capability Network NSW (ICN), in collaboration with the Manufacturing Capability Centres, to be the supply chain matching platform of choice for private and public sector manufacturing projects (at all levels – from Tier 1 down). This should include sufficient funding to adequately service regional areas and a new specific focus on Western Sydney.

[Note: In Q4 2021/22 only 30 manufacturing projects (including 22 Defence projects) were serviced by ICN out of a total of 292 projects]

Short term **Medium term**

2.4

That the NSW Government, through the adopted UK Catapult model, sponsor research, collaboration and partnerships between research institutions and manufacturing SMEs for developing commercially viable products (or manufacturing technologies) manufactured in NSW. This is to include streamlined arrangements to establish MOU and co-funding arrangements (e.g. IP ownership [as per the recommendations of the Commonwealth Government University Research Commercialisation Taskforce in 2021], laboratory access, and prototyping).

Example models that could be leveraged include the NSW research and innovation networks, focused investments through technology vouchers, increased investments in R&D through new programs such as the $24 million Small Business Innovation & Research (SBIR) program and the $28 million Bushfire Response R&D Mission.

Medium term **Medium term**

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3. Promotion

Manufacturing has suffered from an image problem that is a hangover from traditional manufacturing: a perception of unskilled, dirty, noisy, assembly line type activities. Modern manufacturing is significantly different to this out-of-date image, and promotion of new, clean, skilled, and exciting technology-based manufacturing would increase appeal of these jobs, bolstering the pool of talent in the longer term. By extension, promotion of new entrepreneurial ventures in innovation precincts, building on NSW's competitive advantages in digital technologies, quantum computers, materials science, synthetic biology, artificial intelligence and data analytics will contribute to overcoming the image problem

Recommendations – Promotion

No.	Recommendation	Implementation time frame	Impact realisation
3.1	That the Office of the Modern Manufacturing Commissioner promote and deliver early-stage entrepreneurship activities through a coordinated approach to partnerships with: • Cicada Innovations • Sydney School of Entrepreneurship • Sydney Start-up Hub; Western Sydney Start-up Hub; Sydney Scale-up Hub • MVP grant; Boosting Innovation program • Networks such as Defence Innovation Networks, Hydrogen Network, NSW Smart Sensing Network, NSW Circular and other networks managed through the NSW Office of the Chief Scientist and Engineer.	**Medium term**	**Short term**
3.2	That the office of the Modern Manufacturing Commissioner plays a Public Relations role through marketing and other campaigns, in collaboration with industry associations and alliances, to raise awareness of modern manufacturing as high-tech, clean, and using emerging and exciting technologies. For example, the NSW Modern Manufacturing Commissioner could develop programs that raise awareness amongst school students of the opportunities in modern manufacturing and entrepreneurship (for example the Cyber Security Ambassadors program model). The aim is to increase the participation of the next generation in manufacturing, recognising it as an exciting and rewarding long-term career.	**Short term**	**Medium term**

4. Procurement

NSW Government procurement practices should be revised to ensure that the state manufacturing ecosystem is appropriately supported through the award of contracts that stimulate innovation, encourage investment in modern facilities, foster local supply chains, and develop high quality jobs. Such an approach should be evidence-based. Local procurement and co-investment from government, in the place of grants, can reduce risk to government, instil confidence in business, provide business with a highly respected customer, and stimulate local innovation – including for government solutions.

Recommendations – Procurement

No.	Recommendation	Implementation time frame	Impact realisation
4.1	That the NSW Government ensure public procurement is a central part of its industry policy.	**Short term**	**Long term**
4.2	That the NSW Government effectively uses public procurement to support research, development and manufacture of products using contracts – subject to milestone completion and functional delivery. Grants should only be used where the evidence shows they can make the most impact.	**Short term**	**Medium term**
4.3	That the NSW Government change the definition of "value for money" in public procurement to an overall economic benefit test with a long-term view, and develop a systemic set of metrics with a logical equation for procurers to calculate value / benefit. The elements of this equation should include (but not be limited to): • Long-term capability building of manufacturing onshore • Onshore supply chain capability building • Development of R&D and retention of IP in Australia • Local content measures (Australia first / Australian made), in line with WTO rulings and other free trade obligations • Local jobs directly attributable to the procurement • Climate change impacts, mitigations, and resilience • Ethical production (e.g. modern slavery, coercion, etc.) and technology • Building export capability and capacity, achieving international recognition of the NSW Government to improve credibility • Transparency (e.g. supply chain, scope 3 emissions, etc.) • Trust • Social impact • Long-term economic benefit to the state • Other spillovers. The economic benefit to NSW of buying locally also includes benefit to government, such as increased payroll tax and the multiplier effect of spending locally. Including an overall benefit test in the pricing model that looks beyond price may be a way to overcome concerns regarding local procurement provisions.	**Short term**	**Medium term**

4.4	That the Modern Manufacturing Commissioner work with the Commonwealth and other state and territory governments on this procurement approach (Recommendations 4.1, 4.2 and 4.3) to develop a consistent national framework.	**Medium term**	**Medium term**
4.5	That the Modern Manufacturing Commissioner champion the replication and adoption of the ICT procurement policy, process and targets to the manufacturing sector – particularly for NSW SME. This should be in consultation with sector stakeholders, adopting an Australia first policy that: • Is transparent • Publishes results • Includes education recommendations • Makes it easier to do business with government • Is evidence-based.	**Short term**	**Medium term**
4.6	That, once the new procurement processes and value for money definitions are established, the NSW Government conduct a public service education program including a systemic process to quantify cost-benefit analysis (based on the new value for money definition), which protects the procurer. It is recommended that independent, external consultancy experts draft the systemic process.	**Medium term**	**Medium term**
4.7	That any relevant NSW Government procurement is checked and reviewed by the Office of the Modern Manufacturing Commissioner to ensure NSW business opportunities are maximised.	**Short term**	**Medium term**

5. Targeted business support

Targeted business support programs should be built in designated priority areas, to build management and enterprise capability in global markets and value chains, with emphasis on enterprise absorptive capacity and circular economy.

Recommendations – Targeted business support

No.	Recommendation	Implementation time frame	Impact realisation
5.1	That the NSW Government rationalise existing state programs relating to manufacturing. This includes consolidation where possible, early retirement when not performing, extension of the time commitment to successful and newly minted programs and use of industry and professional associations to support program delivery. The performance of all programs should be reviewed on an annual basis as a condition of government support.	**Medium term**	**Long term**
5.2	That the NSW Government, with support from the Modern Manufacturing Commissioner, advocate to the Commonwealth Government for a tax offset for investors in early-stage businesses, similar to the R&D tax offset, with the potential for a sliding scale to be applied.	**Medium term**	**Long term**
5.3	That the Office of the Modern Manufacturing Commissioner adopt the International Centre for Industrial Transformation (INCIT) Smart Industry Readiness Index (SIRI) self-assessment tool (or develop one similar) and make it available for use by NSW Manufacturers.	**Short term**	**Medium term**
5.4	That the NSW Government, with advice and support from the Office of the Modern Manufacturing Commissioner, fund and resource a Modern Manufacturing Support Agency to be headed up by the Modern Manufacturing Commissioner. This should provide concierge type services to help manufacturing businesses to get access to relevant Commonwealth / state / local government grants, funding opportunities and support programs, as well as fast-tracked planning approvals etc. to facilitate the process. The service should: • Include a three-tier, timely, case management service with industry expertise to guide the customer through the support provided by NSW and Commonwealth Governments. The experts could be funded through existing industry associations and/or the Manufacturing Capability Centres, or could include potential secondment of people from industry to provide the service through government, streamlining support and access to governments (at all levels) for NSW manufacturing businesses	**Medium term**	**Medium term**

- Offer targeted and tailored feedback for unsuccessful applicants
- Advise businesses about current grants / funding / support opportunities
- Develop prospectuses for manufacturing in NSW, helping to support FDI (including interstate attraction)
- Disseminate information.

5.5	That the NSW Government develop and deliver a program for manufacturing businesses to adopt productivity-improving technologies and innovations more rapidly, such as automation. The program could include direct funding, co-investment, and/or pre-purchase of products. The funding could assist in tooling up, training, establishing better supply chains, supporting set-up in regional NSW and needs to demonstrate increased productivity. An example model could mirror the Singapore SME Go-Digital co-funding model, with an expanded criteria beyond just digital to support SME adoption of productivity-improving technologies and innovations.	**Short term**	**Long term**

5.6	That the NSW Government, through the Office of the Modern Manufacturing Commissioner, develop a co-investment model for NSW manufacturing businesses looking to access Commonwealth funding. The aim is to encourage more manufacturing businesses to secure a greater proportion of Commonwealth funding into NSW and reduce their barrier to entry. An example model is the NSW Research Attraction and Acceleration Program (RAAP), run by the NSW Office of the Chief Scientist and Engineer.	**Short term**	**Long term**

5.7	That the NSW Government develop and implement a funding and support program for large organisations to encourage contestable and/or accelerated investment or re-investment by the large organisation. Any program developed should also complement efforts to develop a co-investment model with the Commonwealth (as per recommendation 5.6). Support provided could include: • Relocation, infrastructure, and training costs • Fast-tracked planning approvals • Tax relief including payroll and land taxes • Use of the Modern Manufacturing Support Agency to facilitate the process. Criteria must include demonstration that this investment will: • Deliver productivity efficiencies and improvements • Create jobs • Bring other companies, particularly SMEs, into the supply chain • Bring new technologies to bear that are shared with the other companies brought in, taking them to the next level of technology / automation / kit upgrades • Provide and disseminate upskilling and training to the prime and the other companies brought in.	**Medium term**	**Medium term**

5.8	That the Modern Manufacturing Commissioner identify the level of targeted R&D business and translation support that would be appropriate to meet the very substantial challenges in revitalising and reinventing manufacturing in NSW, within the context of the Government's budget envelope.	**Short term**	**Medium term**

6. State / Commonwealth cooperation

Federation impacts the way states and territories compete for Commonwealth and private sector funding and resources. A focus on regional capabilities and strengths, with a future-focused agenda (such as the renewable energy transition) should be the primary drivers of investment, rather than a 'cheque book – race to the bottom' approach.

Cooperation should be enhanced and cost-effective integration undertaken, where appropriate, of state and Commonwealth industry programs. This will avoid sub-scale duplication and fragmented efforts, including in the challenge of knowledge-based Foreign Direct Investment (FDI) attraction.

In addition to building efficiencies into industry programs and attracting FDI, we are now in an era of disrupted international trade and geopolitical tension, with supply chain resilience becoming a much greater priority to ensure Australia can meet the needs of its own citizenry. The Taskforce notes the difference between resilience and sovereignty. Resilience can include supply chain connections with trusted and proven international partners and transport routes, whereas sovereignty requires in situ production lines and materials supply. Sovereign supply chains may not deliver the lowest cost products and services, but they have a higher purpose and must be valued for the greater contribution made to the economy (refer to Recommendation 4.3).

Recommendations – State / Commonwealth cooperation

No.	Recommendation	Implementation time frame	Impact realisation
6.1	That the Office of the Modern Manufacturing Commissioner work with the AMRF and other partners across Australia, including other states, territories and the Commonwealth, to develop a nationwide, coordinated approach to supply chain resilience. This should leverage concentrated specialisation, avoid duplication and promote sustainability. This can be achieved by: • Using the common NSW and Commonwealth priorities as a starting point for building greater cooperation • Identifying areas where there is a need to increase the percentage of Australian components in existing products for supply chain resilience or sovereign capability • Identifying areas of concentrated specialisation, in line with the Commonwealth Modern Manufacturing Strategy focus areas • Further deepening the impact of AMRF to areas in NSW / Australia.	**Short term**	**Medium term**

6.2	That the Office of the Modern Manufacturing Commissioner identify NSW / Australian competitive advantages across the Commonwealth's critical technologies list, identify accordingly where we need to build internal capability and capacity, and identify trusted partners to plug critical supply chain gaps that can't be filled in Australia.	**Short term**	**Medium term**
6.3	That the NSW Government advocate for states and territories to be included in the Department of Industry, Innovation and Science (DISR) supply chain resilience work (once it has moved into DISR) and empower the Modern Manufacturing Commissioner to have a key role in working with other states, territories and the Commonwealth to develop a nationwide approach to supply chain resilience and sustainability, establishing a more coordinated and cooperative approach.	**Short term**	**Medium term**
6.4	That the NSW Government grow Foreign Direct Investment (FDI) with a focus on knowledge-intensive Modern Manufacturing activities, rather than resources, by encouraging a national approach rather than a competitive environment across the states and territories.	**Medium term**	**Long term**
6.5	That the Office of the Modern Manufacturing Commissioner work with other states, territories and the Commonwealth, to set up a States Committee (not at a political level), like the national Chief Scientists' network or the Industry Innovation Science Australia model. The functions of the States' Committees are to: • Act as a coordinator between the Commonwealth and other states and territories on manufacturing issues • Support harmonisation across the states and territories, such as supporting preferred locations for various Modern Manufacturing activities – ensuring competition for manufacturing presence does not devolve to a zero-sum game, but encourages a national approach to attracting R&D Intensive FDI • Provide a consistent voice to both Commonwealth and state and territory regulators • Use National Cabinet and / or Ministerial committees as an avenue for raising relevant topics.	**Medium term**	**Long term**
6.6	That the NSW Government, with the support of the Modern Manufacturing Commissioner, advocate for the establishment of a national forum that brings skills and industry Commonwealth ministers together with states and territories (like the previous Commonwealth Industry Skills Committee (CISC)	**Short term**	**Medium term**

7. Skills and talent

A coordinated program of government and industry support for skills and training should be built, focused on more integrated university-VET pathways, STEM preparation in schools and urgent reactivation of the skilled migration program.

This approaches the skills and talent issues from three angles, addressing:

- Short-term issues through more efficient skills migration actions
- Medium-term through encouragement and incentives for TAFE, other Registered Training Organisations (RTOs), and university students
- Long-term through better teaching and education at the primary and secondary level, including an awareness program dedicated to opportunities in modern manufacturing, entrepreneurship, and business opportunities.

Recommendations – Skills and talent

No.	Recommendation	Implementation time frame	Impact realisation
7.1	That the NSW Modern Manufacturing Commissioner advocate and write to the Commonwealth Government to: • Support both the Business Council of Australia (BCA) and the Australian Industry Group (AIG) recommendations to catch up on lost skilled migration, to maintain recovery by raising the annual permanent migration program to 220,000 people in 2022-23 and 2023-24, reverting to 190,000 in 2024-25 (above the current intake of 160,000), subject to there being no further shortage of skilled workers, and reweighting the skills stream to 70 per cent. Also advocate to increase NSW's share (ensuring family members are additional) based on modelling conducted by the Modern Manufacturing Commissioner • Sufficiently resource the Department of Home Affairs to rapidly process the backlog of visa applications and ensure future applications are processed in a timely fashion • Ensure critical skills are provided for in long-term / permanent visa options • Ensure any visa support for teachers prioritises STEM teachers.	**Short term**	**Short term**
7.2	That the NSW Modern Manufacturing Commissioner works with • Investment NSW to shape the NSW Priority Skilled Occupation List for consideration of manufacturing occupations in consultation with industry • the National Skills Commission to enable a more agile system and for the inclusion of new and emerging Manufacturing occupations on Australia's skilled migration occupation list(s), such as advanced analytics, automation and robotics, creative problem solving and critical thinking.	**Short term**	**Medium term**
7.3	That the NSW Modern Manufacturing Commissioner develops an education and awareness program for industry on employer -nominated pathways to permanent residency. This will enhance the data to the Commonwealth around the skills needs of industry.	**Short term**	**Medium term**
7.4	That NSW Government establish and support a community-led orientation and logistics support program for skilled migrants on arrival in Australia (the Canadian Orientation program could be used as a model).	**Medium term**	**Medium term**
7.5	That the NSW Modern Manufacturing Commissioner advocates to the Universities Admission Centre (UAC) on the importance of mathematics and making the scaling of mathematics to calculate the ATAR more attractive as a subject opportunity. *[The Taskforce welcomes the decision by the NSW Government to make mathematics compulsory for Year 12 students from 2024, which the Taskforce consider essential]*	**Short term**	**Long term**

7.6	That NSW Government design incentives for universities, TAFEs, and other RTOs to offer more places for STEM courses as defined from time to time in consultation with industry; incentives could include manufacturing scholarships and / or cadetships.	**Medium term**	**Medium term**
7.7	The Modern Manufacturing Taskforce supports the Government's decision to make Mathematics a compulsory subject in the HSC from 2024 but recommends that NSW Government improves the teaching of STEM subjects in primary and secondary education through compulsory mathematics training for all primary and specialist secondary school teachers.	**Medium term**	**Long term**
7.8	That the NSW Modern Manufacturing Commissioner work with the Global Business & Talent Attraction Taskforce to identify key source markets of skills (nationally and internationally), targeting promotional activities to stimulate a pipeline of skills and attract exceptional business / talent into NSW manufacturing.	**Short term**	**Medium term**
7.9	That NSW Government, in collaboration with the Modern Manufacturing Commissioner, establish an overarching, coordinating body to drive the workforce transition from coal to new industries, for example in the Hunter Region, which will be enabled by modern manufacturing. The coordinating body should be integrated into the proposed UK Catapult model. Functions of the coordinating body include: • Identifying transferable and upgradable skills in collaboration with Training Services NSW and industry • Supporting the upskilling / reskilling required • Supporting job identification and transition as new industries come online and coal is phased out • Collaborating with planning and local councils to ensure a sensible and practical approach to the locations of new industries • Ensure coal and related declining industries appropriately engage with recycling opportunities to gain further value (for example from critical mineral extraction from old tailings) but do not see this as a substitute for appropriate rehabilitation, which must still be conducted • Advocate the removal of the restriction on the development of a commercially viable container terminal at the Port of Newcastle. This will enable the region to benefit from energy transition, improve freight and port efficiency in NSW, and decongest Sydney's roads and rail.	**Medium term**	**Long term**
7.10	That the NSW Government establish a long-term Women in Manufacturing Fund (WIM) to support female-led manufacturing companies of any size, at every stage of growth. This should increase diversification, boost access to under-utilised talent and develop female mentors and champions for manufacturing. The Modern Manufacturing Commissioner should identify the opportunities to focus the program and align to / leverage existing programs.	**Short term**	**Long term**
7.11	That the NSW Modern Manufacturing Commissioner work with Multicultural NSW to identify skilled refugee and humanitarian visa cohorts (either onshore of offshore) and assist with transitioning them into manufacturing jobs aligned to their skills.	**Short term**	**Long term**

5 Overview of manufacturing and the status in NSW

Challenges of manufacturing in NSW

Manufacturing in Australia is at a critical juncture. On one hand, Australia ranks last in terms of manufacturing self-sufficiency and very low in economic complexity, as exemplified by only 10 companies paying 30 per cent of all tax (Westacott, 2022). On the other hand, NSW is still the largest manufacturing state within Australia, and home to a range of innovative companies that make and export world-leading products, such as GME, Cochlear, Thales Australia, BlueScope, and Nanosonics.

Manufacturing as a capability has been facing challenges for several decades. Some have been more pronounced in Australia, including:

- **Market size and access**. The relatively small size of the Australian domestic market and the physical distance from key global markets (Australia Parliament Senate Economics References Committee, 2022).
- **Energy.** Several submissions to the recent Commonwealth Senate inquiry into the Australian Manufacturing industry identified the cost of energy in an unfavourable comparison with international competition (Australian Steel Institute, 2021).
- **Lack of financial government incentives.** According to Commonwealth Bank, 'the most significant barrier nominated is a lack of financial government incentives'. Apparently access to grants is also an issue: 'While more than 80 per cent of manufacturers know that government grants and support exist, only 39 per cent have accessed them. Large manufacturers and those with emissions reduction targets are far more likely to have secured such incentives (65 per cent), while small manufacturers tend to be the least likely to have accessed available grants (27 per cent)' (Commonwealth Bank of Australia, 2022).
- **Venture Capital Investment.** A relative lack of Venture Capital Investment in NSW, particularly in the Technology Readiness Level (TRL) range of 3/4 to 6/7 (Figure 1), compared to jurisdictions such as Victoria, UK, Canada and Singapore (NSW Innovation and Productivity Council, 2022).
- **Failure to fully utilise R&D.** There are excellent R&D capabilities in pockets of industry and academia that are not fully linked to manufacturing. The R&D capabilities that exist are not yet operating at a scale to be accessible to all the businesses that could potentially benefit from such services. This is a combination of the number of available multi-user facilities and the number of businesses able to afford to partner. NSW ranks first for top universities on a population-adjusted basis, although university-industry collaboration remains a challenge (NSW Innovation and Productivity Council, 2022).

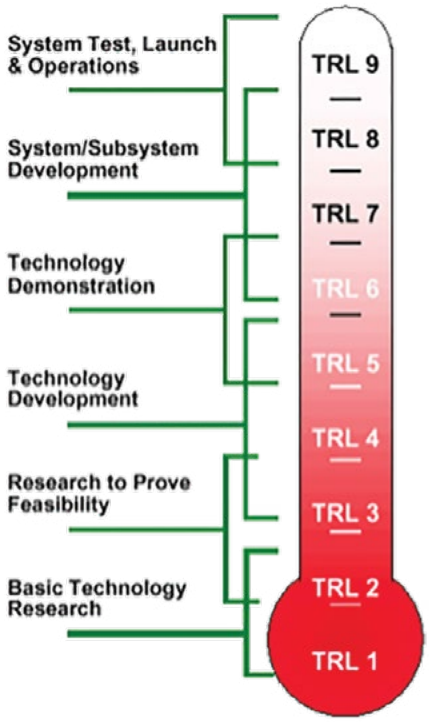


Figure 1. Technology Readiness Levels, as developed by NASA in the 1970s, represent a consistent way to estimate the maturity of technologies over the research, development and adoption process

Failure of R&D translation

A classic example of the loss of NSW excellence in R&D to savvy international investors and developers is the Photovoltaics Australian story. Developed at the University of NSW, photovoltaic technology was hailed as the great success that it was, but a lack of vision, commitment, and incentives meant that the technology was lost to overseas competitors – particularly to China. "Given manufacturing capacity under construction, China will soon account for 95 per cent of the world's production of polysilicon, ingots and wafers" (How, 2022). "China has invested more than US$50 billion (AU$73 billion) in new PV supply capacity – ten times more than Europe – and created more than 300,000 manufacturing jobs across the solar PV value chain since 2011" (International Energy Agency, 2022). This lack of diversification in the supply chain is also a considerable vulnerability, not just to Australia, but the world in general.

The impacts of this are now coming home to roost – "Australia has run a more than $7 billion trade deficit on solar panels and associated components over the last five years"(How, 2022). This is due to several reasons – the loss of the intellectual property and first mover advantages, as well as the potential for sustainable solar panel manufacturing in Australia being inhibited by its predominantly coal-based energy mix, which raises our carbon emissions in the production of these technologies (How, 2022).

The IEA notes the key to competing with China is low-cost electricity (International Energy Agency, 2022).This can be achieved through transitioning to renewable energy sources, allowing competitive onshore production of renewable technologies, diversifying the supply chain and de-risking this vulnerability, as well as improving the balance of trade and creating high-tech manufacturing jobs.

Don't repeat the failure

We now have a similar situation arising with Quantum technologies. This year, Professor Michelle Simmons AO, founder and CEO of Silicon Quantum Computing, announced her team had manufactured the world's first integrated circuit at the atomic scale, which has been peer-reviewed and published in Nature (Simmons, 2022): an absolutely outstanding effort that comes years ahead of when this breakthrough was predicted.

But we must ensure we do not repeat the Australian Photovoltaic story and learn from that mistake. Australia, and in particular NSW, has significant competitive advantage and skills across the full stack of Quantum Computing technologies (Turner, 2022). It's a competitive advantage we will only keep if there is sufficient vision, commitment and incentives from government to get this technology through the valley of death TRLs.

However, in this instance, there is an even greater imperative to ensure Australia captures the first mover advantage with this technology. Quantum technologies offer the potential to make current encryption useless, exposing our vital systems including military, financial, banking, cyber, etc. Therefore, building our own hardware and talent is even more important so Australia has control of its own quantum computing technologies, and is able to stay ahead of the curve on issues such as post Quantum Cryptography.

Decline of manufacturing in NSW

To put the decline of manufacturing in NSW into context, its growth on an Annual Average Growth Rate (AAGR) basis is the lowest of all industries over the 20 years to 2020-21 at -0.6 per cent, and third lowest in the last 10 years.

Services have recorded the strongest growth rates over the last two decades, reflecting the experience of most advanced economies as consumers' wealth and incomes grow. NSW manufacturing industry growth over the last 5 years has been positive, at 0.4 per cent AAGR, but still lags behind many other industries (Figure 2).

In fact, the NSW manufacturing industry gradually lost share of the national total over the last 30 years, mainly to Queensland and Western Australia (although they are coming off a lower base), though in recent years this downward trend has stabilised. NSW remains the largest manufacturing state in Australia, based on Industry Value Add (IVA) but sits only just above Victoria (Figure 3).

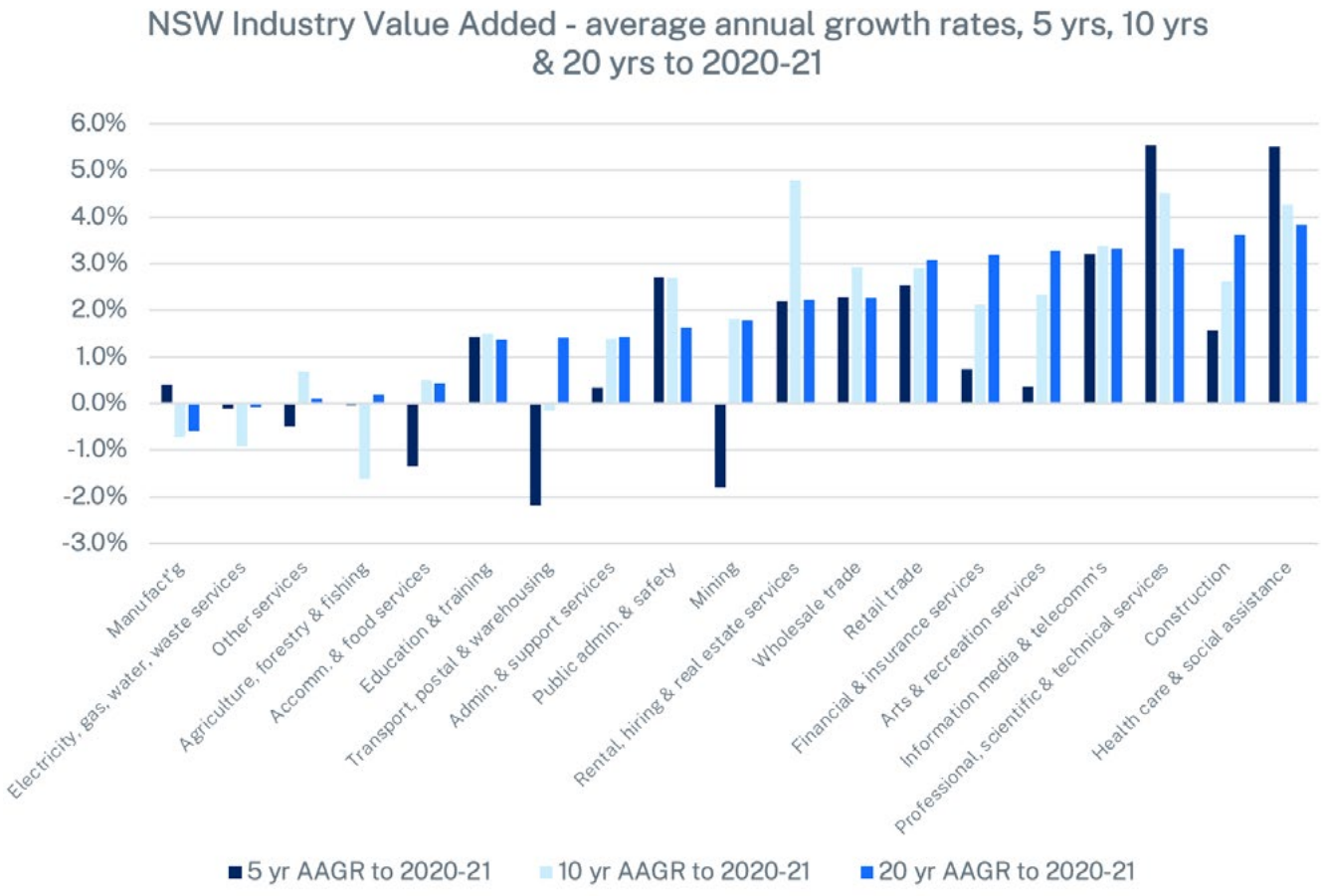
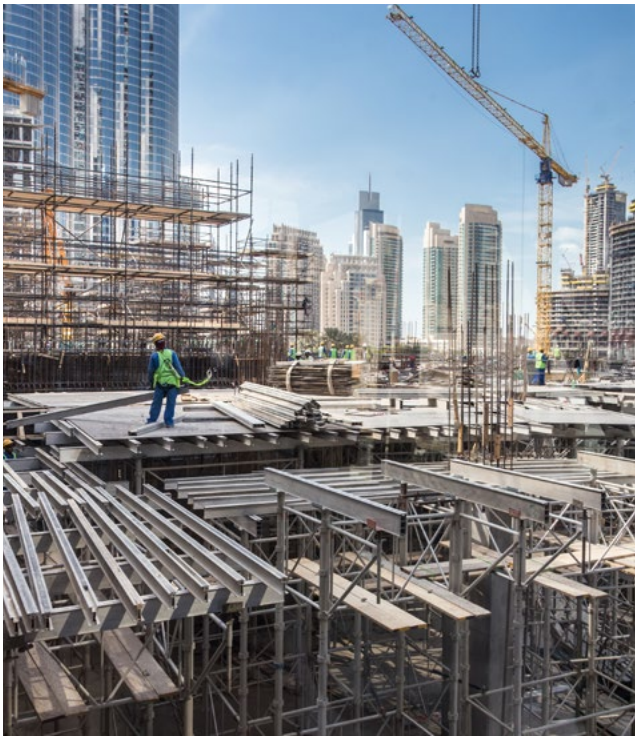


Figure 2. NSW Industry Value Added comparisons: 5, 10 and 20 years to 2020-21



Growth in labour productivity is recognised as the key driver for improvements in living standards and is a widely accepted productivity measure. Labour productivity growth in Australia has slowed since the mid-2000s, as has been the case for many advanced economies. In 2020-21, manufacturing productivity growth exceeded the market sector average (which excludes education, health, and public administration), but has tended to lag over the last decade (Figure 4).

In 1985, the NSW manufacturing industry was the state's largest employer. In 2022, it ranks ninth largest and has followed a downward trajectory over this time due to automation, offshoring / outsourcing, and a structural shift towards services (Figure 5).

Victoria now employs more people in manufacturing than any other state, though, like NSW, it has been on a downward trajectory for the last few decades. Meanwhile, Queensland, and Western Australia to a lesser extent, have recorded increases (Figure 6).

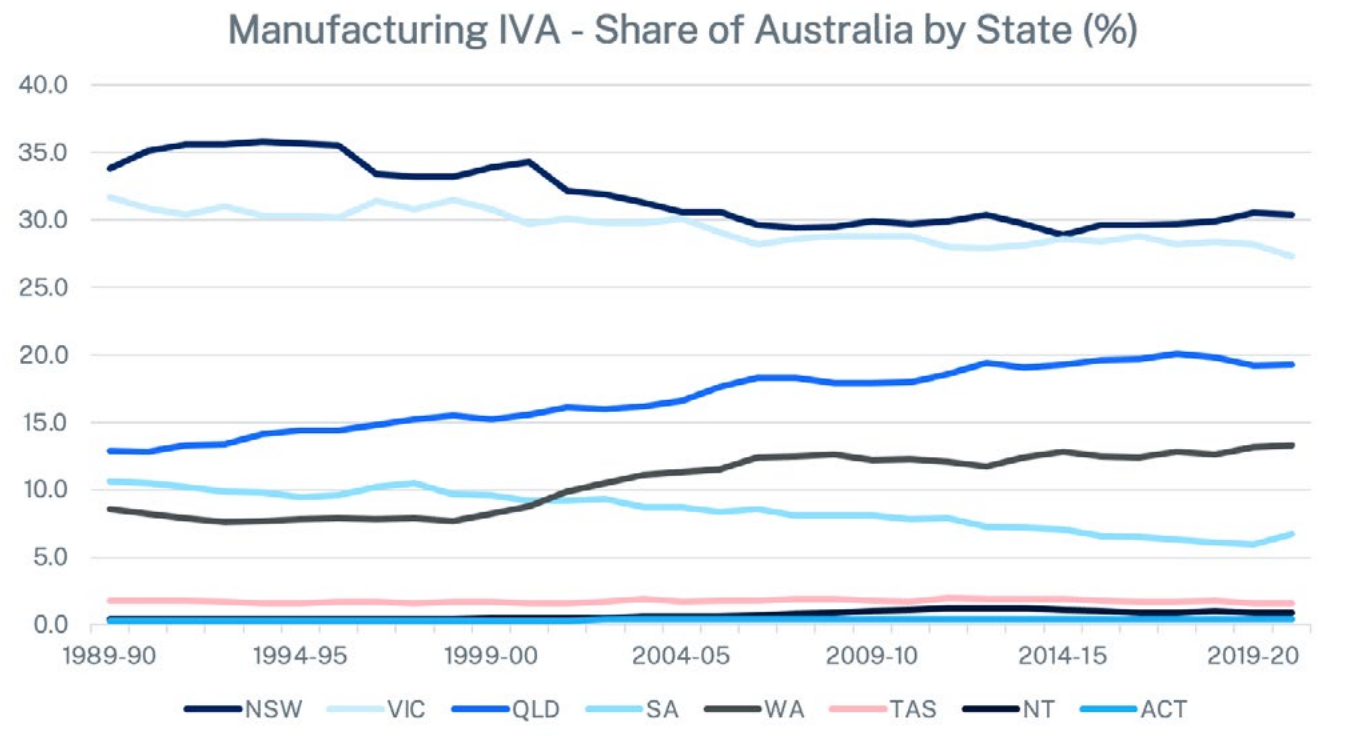


Figure 3. Manufacturing Industry Gross Value Added share of Australia by state (per cent)

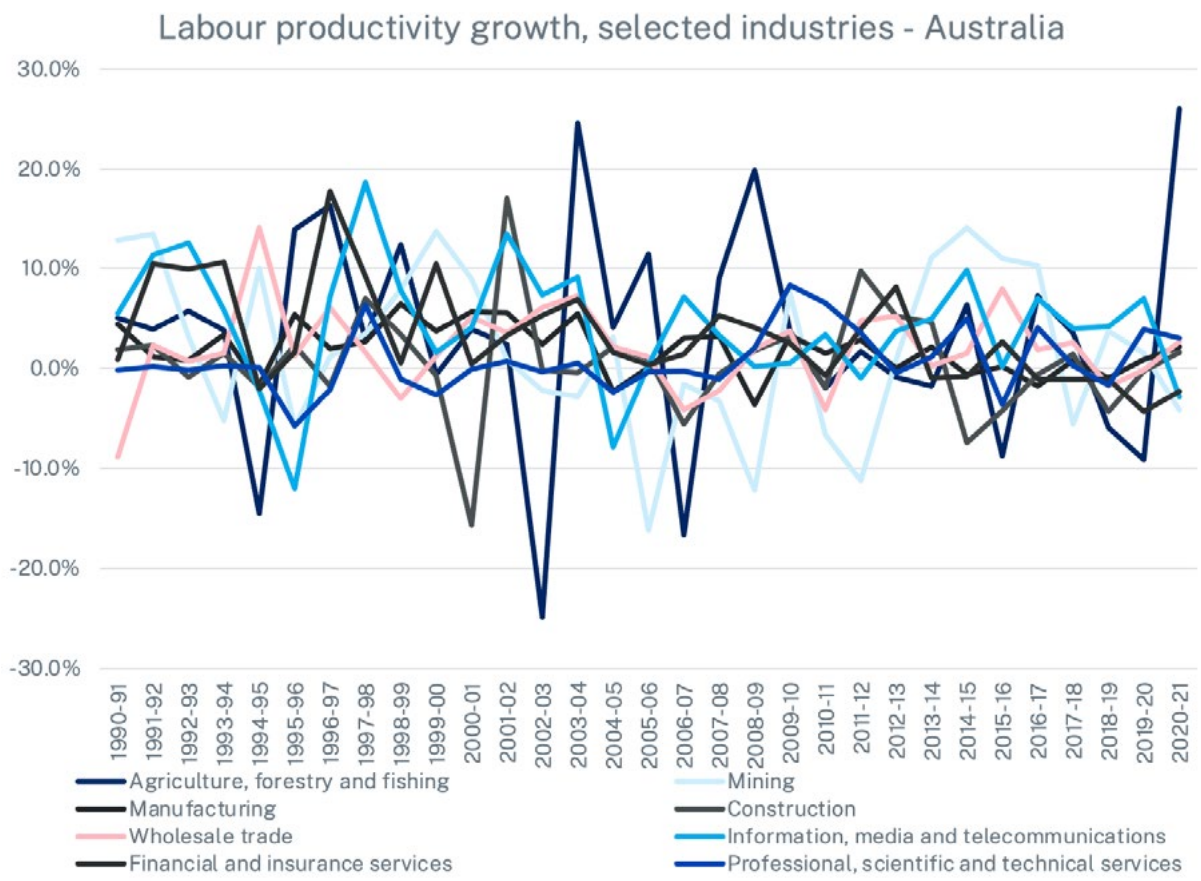


Figure 4. Labour productivity growth, selected industries – Australia

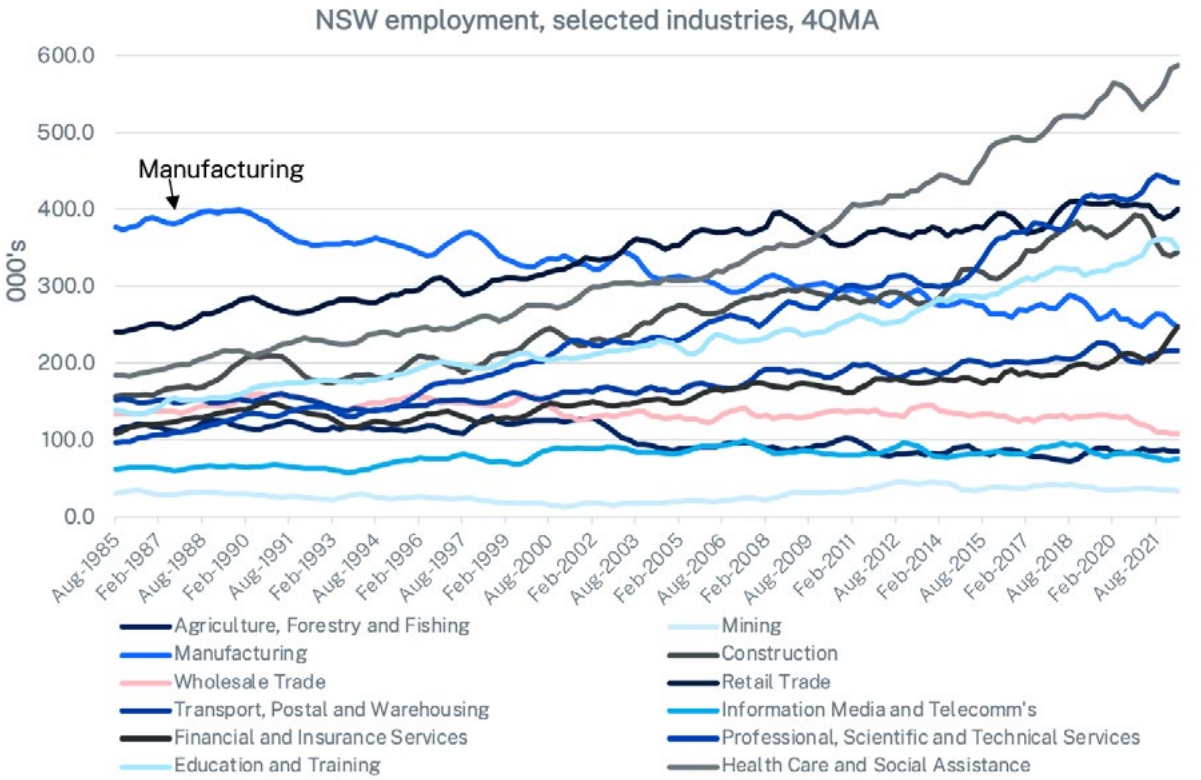


Figure 5. NSW employment comparison of selected industries

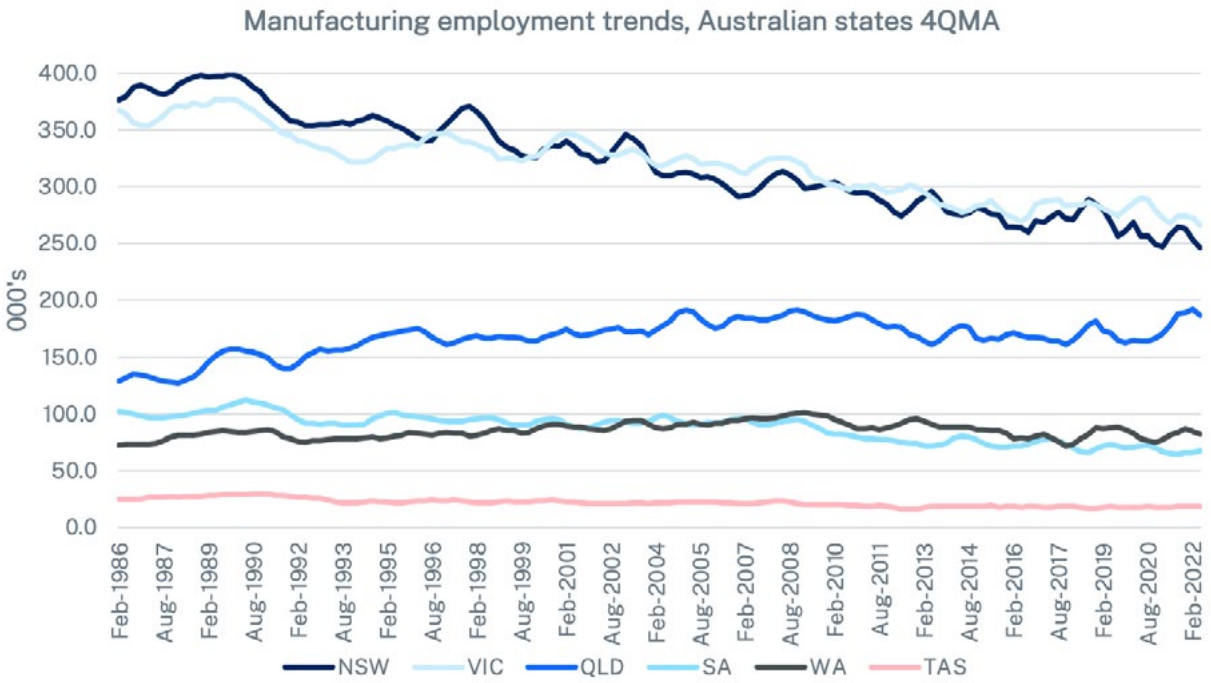


Figure 6. Manufacturing employment trends across Australian states

Additionally, our economic complexity rates are very low with an index at -0.53, compared to Germany with an index of +2.09 (Figures 7 and 8). This means that we rely too heavily on just a few sectors for our GDP and economic growth, in particular mining and resources, tourism, and agriculture. Insufficient diversification of the economy increases our exposure to risk. This has been exemplified recently through COVID-19 impacts on tourism and natural disasters on agriculture. However, a modernised, diversified and growing manufacturing sector can help to address this issue.

The future challenge for manufacturing is not simply one of increasing the percentage of GDP generated by the industry. The challenge is to effectively utilise modern manufacturing technology and productivity gains to ensure that the products made in Australia are those that benefit our economy, lifestyle and national security. In a globalised economy, no single country will produce everything – but Australia can exercise control over what we do produce.

By way of example, the USA manufacturing sector in 2022 employed 8 per cent of the non-farming workforce, down from over one third of the workforce 70 years ago. As manufacturing productivity has increased, the need for workers has decreased. Efforts to return overseas manufacturing to the USA are driven, in part, by a desire to secure supply chains. New manufacturing technologies that increase productivity are the key to achieving this security at a competitive price.

According to the Australian Productivity Commission (writing in 2003), the declining share of manufacturing over time is not an Australian idiosyncrasy, but a common feature of economic development. 'Among 17 "rich" countries, only one (Singapore) experienced an increase in the share of manufacturing in nominal GDP over the two decades from 1978. In contrast, manufacturing increased in importance in eight of 18 poorer countries (sic), consistent with the role of manufacturing in the development phase of countries' (Australian Government Productivity Commission, 2003).

The Commission went on to say that 'structural changes associated with these developments has meant that developed economies are becoming, in one commentator's terms, increasingly 'weightless', with economic power relying more on the exploitation of knowledge and services, rather than the capacity to manufacture things, dig them up or grow them. Manufacturing is undergoing the same transformation in role that saw agriculture's relative importance decline over the twentieth century.' (Australian Government Productivity Commission, 2003)

Economic Complexity: Australia 87 of 133

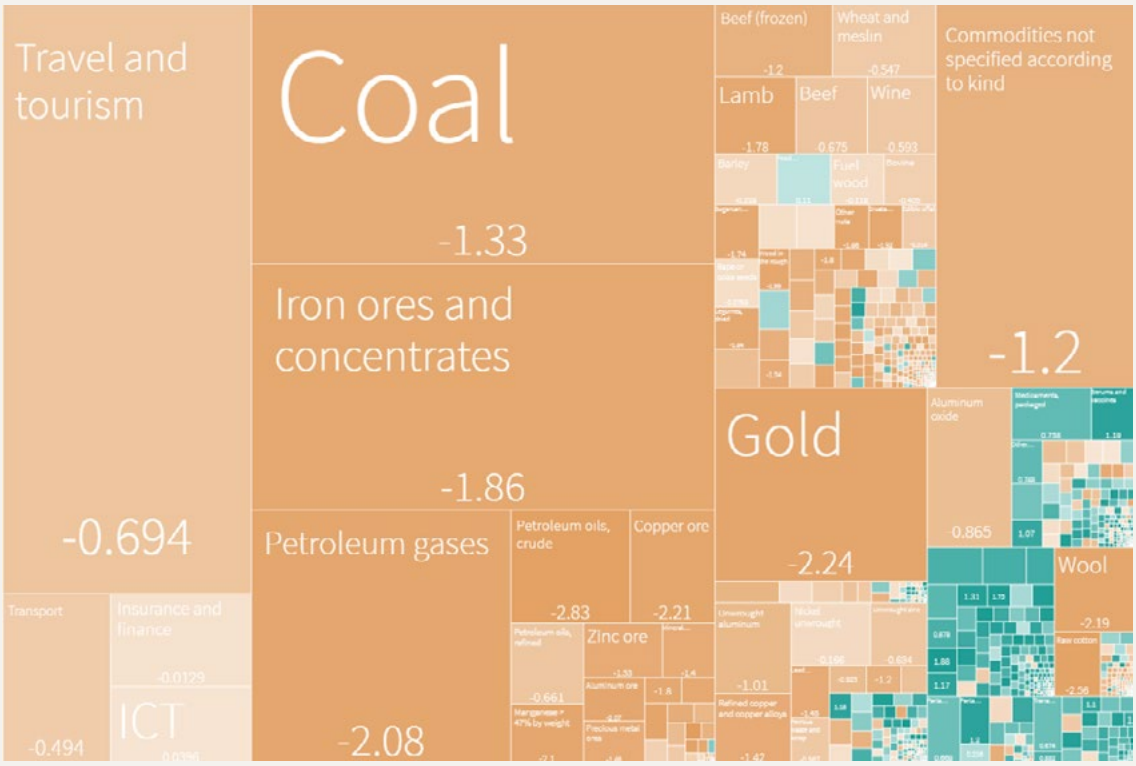


Figure 7. Australia's economic complexity index is -0.53

Economic Complexity: Germany 4 of 133

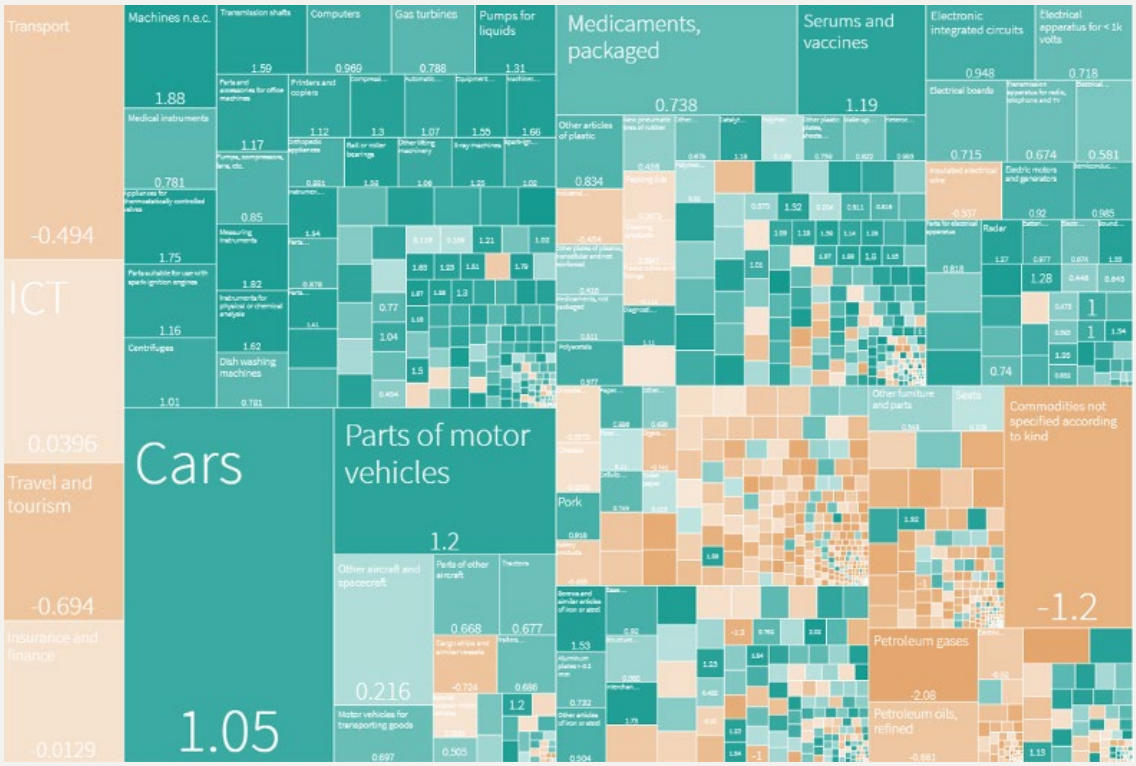


Figure 8. Germany's economic complexity index is +2.09

The graph below (Figure 9) depicts percentage changes in manufacturing jobs in countries nominated by CB Insights over the period 2001-2017, showing a new phase in the global movement of jobs (at least in some locations).

It illustrates an apparent return of jobs to the USA and some European countries, with percentage losses most notable in China. If NSW were to appear on the graph, it would show percentage reductions for the manufacturing workforce of 1.7 per cent from 2001 to 2007, 1.4 per cent to 2014 and 0.8 per cent to 2017. Interestingly, the rate slows further from 2017 to 2021 over which time we saw a 0.6 per cent reduction. At that time, the number of NSW workers in manufacturing was 262,800 out of the state's 4,096,8000 (Sanderson, 2022) – still about 30 per cent of Australia's manufacturing jobs.

The trend that concerns these NSW jobs in 2022 is whether the Industry 4.0 transformation, combined with uncertainty regarding supply chains and a desire to build sovereign industry capabilities, leads to a similar 'return' of manufacturing jobs to NSW and Australia. The economic benefits driven by such 'regrowth' will be driven largely by productivity improvements available from Industry 4.0. We have an opportunity to determine what these jobs will manufacture in order to best contribute to the economy as a whole.

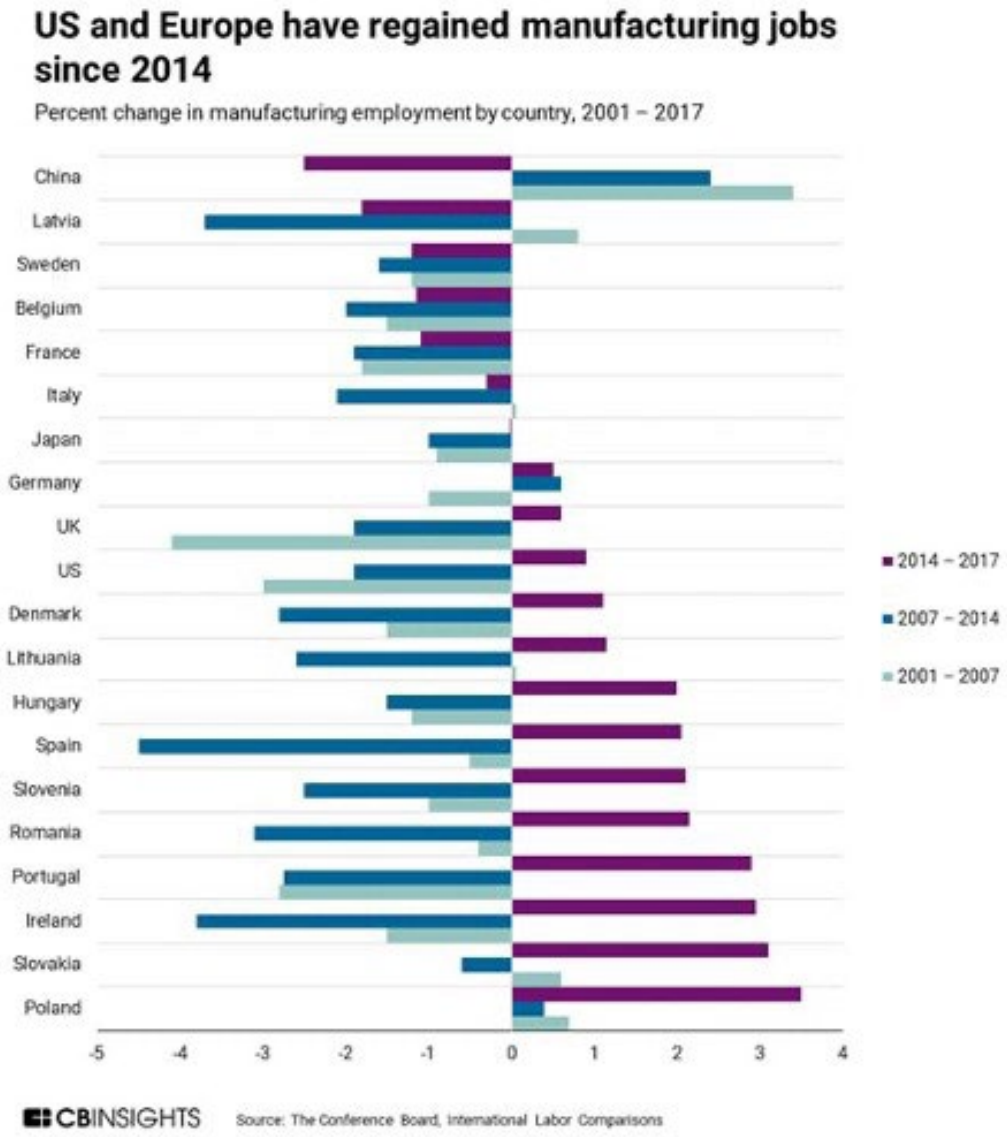


Figure 9. Change in manufacturing jobs by country 2001 – 2017

Opportunities for manufacturing in NSW

Approach

To reverse these trends, we need to look to modern manufacturing. The future of manufacturing in NSW lies in its modernisation. Due to higher input and export costs compared to our international competitors, NSW cannot compete internationally on price, and must adopt the *Fraunhofer and Flanders Make* philosophy of **better not cheaper**, and sustainable. This is not just about the development of new industries, but the transformation of existing ones. NSW has significant ongoing examples of this philosophy in action: international breakthroughs in Quantum Computing, Medtech, Biotech, Agritech, Green Steel, and so on.

Quantum Computing

A highly topical and contemporary example is the significant opportunities and competitive advantages NSW has in Quantum Computing. There are numerous Quantum Computing companies in Australia, with a concentration in NSW, which are developing different aspects of Quantum Computing, many collaborating with the nation's research institutes and universities. The developments in Tech Central around the Quantum Terminal and the Sydney Quantum Academy are further supporting NSW's position in Quantum technologies. Collaboration examples include:

- **Silicon Quantum Computing,** recently announcing the manufacture of the world's first integrated circuit at the atomic scale, has a short-term aim of producing a 10-qubit prototype quantum processor by 2023, and a more powerful 100-qubit quantum processor before 2030. Its director is Michelle Simmons, Scientia Professor of Quantum Physics at the University of NSW and 2018 Australian of the Year.
- **Q-Ctrl** has developed a global reputation for building software to stabilise and improve the performance of existing quantum hardware. Its founder and CEO, Michael Biercuk, is professor of quantum physics and quantum technology at the University of Sydney. Q-Ctrl has customers in the university scene and national and government labs all around the world.
- **Quantum Brilliance,** a German-Australian start-up, has built a two-qubit diamond quantum "accelerator" that uses synthetic diamonds and runs at room temperature in any environment, and is collaborating with CSIRO's Data61. The accelerator system is due to be tested by pairing it with a new state-of-the-art supercomputer, Setonix, at the Pawsey Supercomputing Research Centre in Perth.
- **Quintessence Labs,** offers data protection enhanced by quantum encryption.
- **QuantX Labs** is developing advanced quantum sensing solutions for precision timing, Earth observation and space exploration (Griffith, 2022).

Anthony Murfett, Head of Division Technology and National Security at the Department of Industry, Innovation and Science, notes:

> *"They're the type of things Australian companies and researchers are thinking about and it's why we're so world leading."*
>
> *– (Griffith, 2022)*

But the race is on: Quantum Computing is experiencing exponential growth globally.

"There is an international race to build a scalable, error-corrected quantum computer that fundamentally transcends the limitations of conventional supercomputers. Australia is at the very forefront of this field having established the Centre of Excellence for Quantum Computing Technology back in 2000. Whilst early prototype quantum computers are accessible on-line, they are of insufficient quality and size at this stage of development to outperform classical computers. As a consequence, there is intense international interest in the ongoing development of this disruptive technology, with investment rapidly growing and standing at over USD$31 billion by governments globally"

– (Simmons, 2022) (Figure 10).

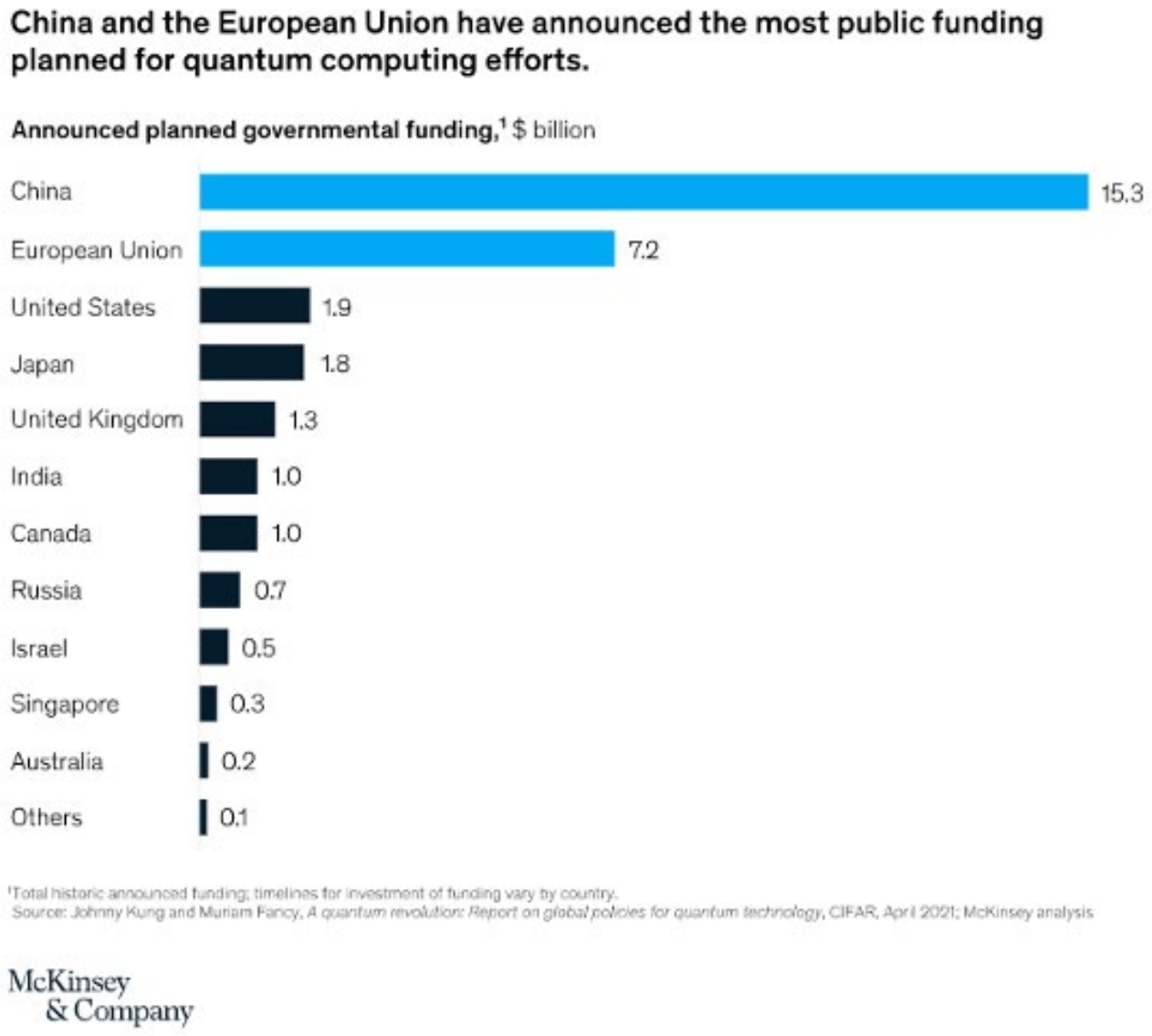


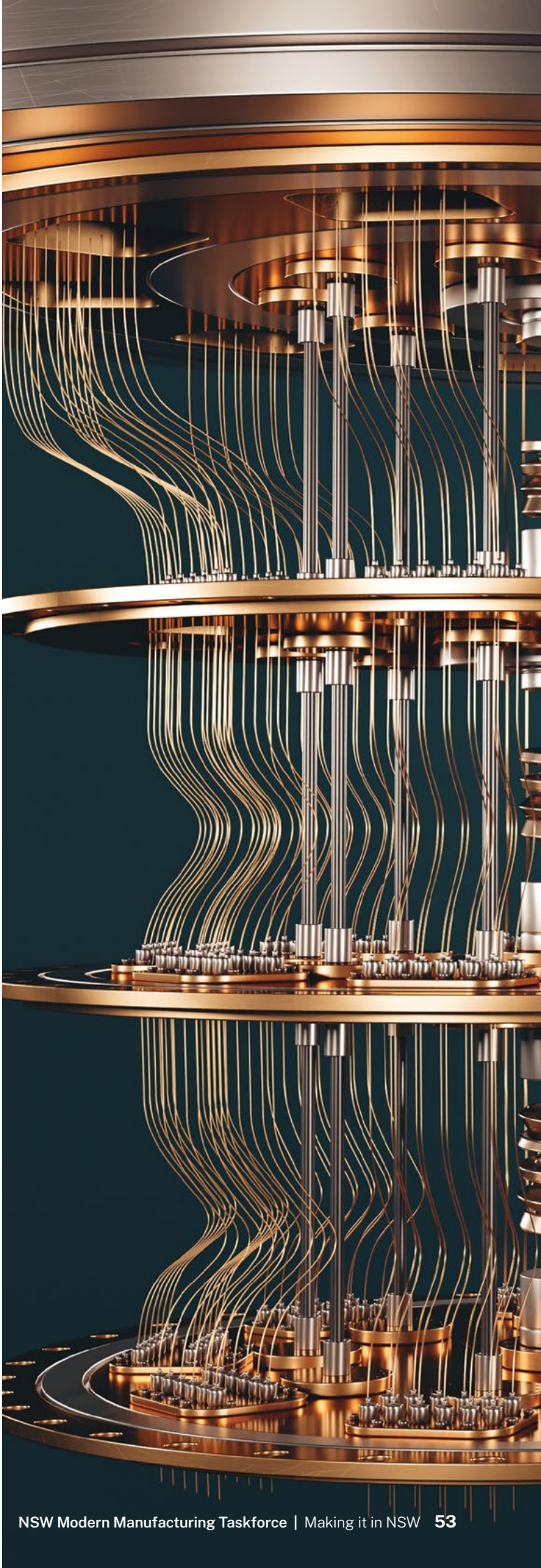
Figure 10. Global investment by governments into Quantum Computing

Australia is well positioned in a global Quantum Computing market, with competitive advantage across the stack.

"Although Australia's publicly announced forward investment is currently low relative to other countries, Australia invested earlier in the technology than other players and has consequently demonstrated clear international leadership in key aspects of quantum computation research. Australia has exceptional skills and strong intellectual property portfolios in silicon and photonic qubit technologies, with significant world leadership in the atomic manufacturing technologies required to fabricate quantum processors in silicon at the atomic scale. The challenge now is to ensure ongoing support to maintain this leadership position as other, larger countries invest heavily in their own quantum computing capabilities."

– (Simmons, 2022)

The challenge for Quantum Computing is echoed across other manufacturing sectors, where modernisation of manufacturing is required to either maintain leadership or increase our capacity to effectively compete internationally where we have strengths and competitive advantages.



Decarbonisation and the circular economy

Many businesses have already made, or are in the process of making, investments into modernisation, however, more needs to be done to ensure an equitable playing field and that the building blocks are in place to encourage a thriving, strong, diverse, and growing modern manufacturing capability in NSW. Indeed, this will be vital and necessary to transition from a carbon-based economy, both domestically and internationally, and necessary to meet the various governments' emissions targets. But this also provides NSW with huge opportunities, for example in green energy production, recycling, and the circular economy, all reliant on modern manufacturing. This is a win-win for NSW, enabling us to meet emission targets while, for example, placing us in a prime position to become a green energy supplier to the world.

NSW already has many of the ingredients in place:

- Abundant natural resources, including critical and rare earth minerals
- World-class research capability
- High levels of education and access to talent, although the scale and the translation of R&D needs more focus along with a direction of talent into manufacturing
- Internationally favourable advantages across multiple emerging technologies (McFarland, et al., 2022)
- First-class infrastructure and connectivity
- Regional hubs and special activation precincts for sector specialisation and collaborative sharing of expertise and resources
- Pockets of high-tech, modern manufacturing trailblazers
- An enviable lifestyle and work / life balance (Constantz, 2022). A society that provides this is peaceful, harmonious, fair, and prosperous with a rule-based system of law with strong social safety nets (Torfs, 2022)

With an expanded modern manufacturing capability, NSW can leverage its world-class research and development, natural renewable energy endowments, and vast array of critical and rare earth minerals to the benefit of the NSW economy and its citizens.

UNIVERSITY OF WOLLONGONG AUSTRALIA

The University of Wollongong (UOW) is working closely with industry, research partners, governments, universities and VET providers **to develop Australia's circular industrial economy**, reduce emissions, equip an appropriately skilled workforce for sustainable change, and provide solutions to support existing and emerging businesses as they look to adopt modern manufacturing technologies and innovative systems.

Hydrogen technology commercialised

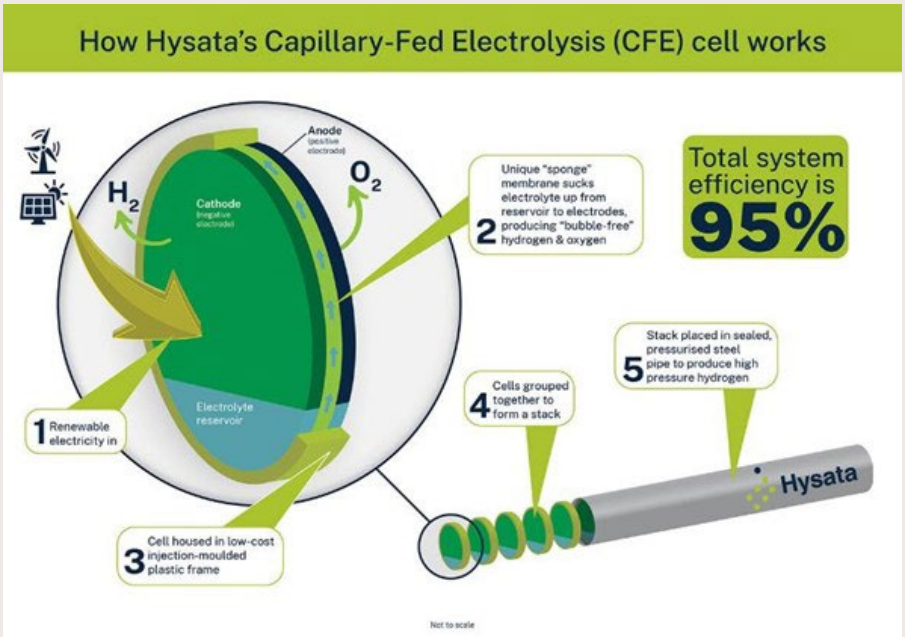
A company spun out from UOW is working to commercialise breakthrough Australian hydrogen electrolyser technology that brings cost-competitive renewable, or green, hydrogen, closer to reality.

The world-leading electrolyser is based on breakthrough technology developed by a team from the UOW-headquartered ARC Centre of Excellence for Electromaterials Science (ACES). Hysata is based at UOW's Australian Institute for Innovative Materials (AIIM).

The company's overall electrolyser system has been designed for ease of manufacturing, scaling and installation, delivering 95 per cent overall system efficiency, equivalent to 41.5 kWh/kg, compared to 75 per cent or less for existing electrolyser technologies.

For hydrogen producers, this will significantly reduce both the capital and operational costs to produce green hydrogen.

The company's electrolyser will deliver the world's lowest cost green hydrogen, save hydrogen producers billions of dollars in electricity costs, and enable green hydrogen to outcompete fossil fuel-derived hydrogen. The technology will enable hydrogen production below US$1.50/kg per kilogram by the mid-2020s, meeting Australian and global cost targets much earlier than generally expected. This is critical to making green hydrogen commercially viable and decarbonising hard-to-abate sectors.



See Appendix 3 for the full case study.

For more details: https://hysata.com/, https://www.uow.edu.au/media/2022/breakthrough-opens-door-to-low-cost-green-hydrogen.php, and https://www.nature.com/articles/s41467-022-28953-x

Sectors of interest

Sectors of interest in the state for the application of modern manufacturing techniques include:

- **Advanced materials.** The production and integration of advanced materials will be key to the development of new high-value sectors. Opportunities include specialised components with unconventional and new feedstocks like lightweight materials, carbon fibre, biological materials and pharmaceuticals.
- **Re-cycle, recover, re-use and re-manufacture.** So-called 'closed loop' systems based on principles of recovery, re-cycling, re-use and re-manufacturing reduce waste and energy consumption as well as reduce reliance on imported materials.
- **Digitisation and automation.** Implementation of these technologies to use smart and flexible digitised manufacturing would allow manufacturers to pivot their production lines and update products. Implementation does not only involve acquisition of machines and software, but also the modernised design of the entire manufacturing process and supply chain.
- **Clean energy.** As raised in the BlueScope submission to the Standing Committee on State Development's Inquiry into the development of a hydrogen industry in NSW, an affordable and reliable low emissions energy supply is an essential long term government objective at both state and Commonwealth level.

The NSW Government has recognised the importance of modern manufacturing and is appointing a Modern Manufacturing Commissioner to revitalise the NSW Advanced Manufacturing Strategy and champion and chaperone its implementation.

UNIVERSITY OF WOLLONGONG AUSTRALIA

UOW is **working toward an inclusive clean energy future** -energy transformation that accommodates social, economic, and technical issues. Energy transformation has regional significance to the Illawarra as manufacturing and mining operations in the region are investigating clean energy options. There is a substantial skills base in manufacturing and mining, providing plenty of opportunity for retraining and transitioning of the workforce.

ARC Research Hub for Australian Steel Innovation (Steel Research Hub)

UOW headquarters the ARC Research Hub for Australian Steel Innovation – the Steel Research Hub (SRH), which is focused on decarbonisation opportunities for the steel industry. The second Steel Research Hub commenced in late 2021, following the completion of the first hub earlier that year.

The new SRH has eight industry partners, including BlueScope Steel, and brings together teams of internationally recognised research and industry talent to deliver innovative solutions and breakthrough technologies in steel manufacturing and product development.

The $28 million research program is designed to support the transition of Australia's steel manufacturing industry to a more sustainable, competitive, and resilient position, based on the creation of new, higher value-added products and more advanced manufacturing processes.

Product innovations in the first SRH included a project to develop a self-cleaning, antimicrobial organic coating for painted steel to prevent the build-up of mould, algae and other bacteria on steel surfaces.

A joint research team comprising members from UOW, BlueScope Steel and the University of Queensland investigated the challenge of producing smooth, uniform, thin metallic alloy coatings on high-quality coated steel products. Coated steel products – such as corrosion-resistant metallic alloy coated steels – are important for Australian steel manufacturers, particularly in building applications that must withstand harsh climate for extended periods.

Another project from the first SRH focused on the sustainable recovery and utilisation of iron and flux units from steelmaking dust. Maintaining a strong social and environmental perspective is an essential requirement of modern steelmaking.

Other case studies demonstrating outcomes from Steel Research Hub 1 can be found at www.uow.edu.au/steel-research-hub/previous-steel-research-hub-2014-2020/

See Appendix 3 for the full case study.

Competing in international markets (exports)

In its submission to the Senate Inquiry on Manufacturing, the Gattan Institute noted 'Australia has resources that will provide a comparative advantage for energy exports and manufacturing in a carbon-constrained global economy. These include solar and wind on the energy supply side with the potential to produce competitively priced hydrogen, and mineral resources critical in ongoing and emerging industries, including iron ore, bauxite, copper, nickel, and lithium'. (Grattan Institute, 2021)

The Australian Steel Institute agreed, noting that 'renewable energy infrastructure is the key area where Australian manufacturing industry has the potential to grow and establish world class capability with long term export potential. This view is based on the significant forecast demand for investment is this area in Australia.' (Australian Steel Institute, 2021)

CSIRO notes 'Value-adding downstream processing of minerals: By adopting advanced processing and refining, Australia can increase the value of minerals before export, producing refined metals, pre-cursor chemicals, alloys and high-end engineered products. This can create high-tech jobs and industries, strengthen supply chains and lower the environmental impact of resources.' (Wynn, 2020)

Senator Patrick, in his additional remarks to the Senate Inquiry report on manufacturing, noted that Australia has an opportunity to pivot from minerals exports to manufactured goods exports: 'The Commonwealth Government must take action to establish the environment that supports investment in and support for Australian manufacturing and capitalising on Australia's elements of difference that can provide advantage. Imagine using our gas to give our manufacturers cheaper energy, gaining an advantage over foreign competitors (instead of giving our gas away to multinational companies who give us nothing for our resource). Or our lithium to establish a battery manufacturing Industry[1], rather than supporting foreign battery manufacturers.' (Australia Parliament Senate Economics References Committee, 2022)

Achievements from the 2018 Advanced Manufacturing Strategy

In 2018, the NSW Government launched its Advanced Manufacturing Strategy. So, how has NSW progressed in a measured sense on this Strategy?

It is important to note that the NSW Advanced Manufacturing Industry Development Strategy (2018) was unfunded, so all its achievements were made by agencies and business units undertaking delivery of their own programs. In most cases, these were delivered independently of the strategy but still qualify due to their alignment with it and are therefore included in reporting. In each of the below, the agencies and/or Investment NSW units or its predecessors have been specified.

The 2018 Strategy has four high-level initiatives, which were helpful in setting a focus and direction, but it was unable to deliver any of its own programs as it was not funded. To support the incoming Modern Manufacturing Commissioner, annual reporting for the 2021-22 Financial Year on the delivery of the 2018 NSW Advanced Manufacturing Strategy is provided below. A more detailed summary of the outcomes is provided in **Appendix 2.**

To have impact and longevity on modern manufacturing in NSW, any future strategy must be sufficiently resourced and funded.

1. It is noteworthy in this regard that Energy Renaissance recently developed (with support from Investment NSW) Australia's first advanced lithiumIon battery manufacturing facility in Tomago, NSW, employing up to 200 staff.

Outcomes from the four initiatives under the 2018 Strategy

Initiative 1

Facilitate the development of advanced knowledge to foster collaboration and research within the industry and with research institutions.

- What have Industry 4.0 government initiatives delivered in terms of the extra number of skilled workers?
  - 28 learners (a mix of digital apprentices and existing workers) in NSW are going through the Training Services, Department of Education Diploma of Applied Technologies.
  - An additional 17 learners from 8 manufacturing businesses (sourced by Investment NSW) have recently gone through the Driving Digital Skills pilot program. Further detail on the Driving Digital Skills program and outcomes is provided in **Appendix 2.**
  - Concurrently, there are many NSW students undertaking Training Services Short Courses which consist of Industry 4.0 training.
- How many digital apprentices are currently supported?
  - 8 are currently undertaking the Training Services program with a few more commencing soon.

The Modern Manufacturing Taskforce notes that the number of learners through these programs seems to be on the low side. Given the shortfall, the program needs to be sufficiently resourced and funded to increase the uptake.

- How did the digital micro credentials go? How many were awarded?
  - The Western Parkland City Authority is developing a New Education and Training Model (NETM) in partnership with industry, universities, vocational education and training (VET) providers and government.
  - The NETM will deliver small-scale packages of learning, or micro-credentials, that allow people to build knowledge, skills and experience in a particular subject area aligned to employer needs.
  - The third cohort of students is still progressing through the program, so it is too early to provide any qualitative data and no information is available on program completion.

The Modern Manufacturing Taskforce notes that digital micro credentials would be useful, but more data is required to determine the success (or otherwise) of the initiative.

- How many schools have been linked to industry?
  - Approximately 600 students and 80 others accessed the Investment NSW / Department of Education Training Services Australian Manufacturing Week webinar designed to encourage student uptake of manufacturing careers. Several school groups hosted by Investment NSW and the Department of Education also toured the Manufacturing Week exhibition.
  - 38 NSW schools have participated in the STEM Industry School Partnerships (SISP) Program administered by Training Services.

The Modern Manufacturing Taskforce notes that the goal here should be to establish permanent and ongoing school linkages. The "adopt a school approach" could be considered to develop this idea further, for example BlueScope could adopt Wollongong High School. It is noted that the NSW Department of Education Regional Industry Education Partnerships (RIEP) program has many other activities connecting schools to industry and should be utilised further to improve these linkages.

Initiative 2

Drive the adoption of advanced processes to support and facilitate skills development in the NSW manufacturing industry.

- How many grants and how much under the energy efficiency funding program were awarded? What's the Net Present Value (NPV) of the energy savings?
  - As at January 2022, the Manufacturing Efficiency Funding administered by Department of Planning and Environment had achieved:
    - » $6,759,600 funding awarded to business to date via 293 contracts.
    - » 67 Round 1 and 2 projects completed to date.
    - » 146 projects completed under the compressed air and steam services offers.

- The successful Round 2 projects to date are expected to save:
  - » 7,766 MWh of electricity which is equivalent to over 400 times the average annual energy consumption of Australian industrial cool rooms and freezers
  - » 27,513 GJ of gas
  - » At least 7,265 tCO_2-e which is equivalent to running more than 3,000 passenger vehicles per year
  - » $1.4 million in energy bills each year.
  - » Refer to the 2020-21 CCF report for more information.

The Modern Manufacturing Taskforce notes that the Manufacturing Efficiency Funding is working well based on the statistics provided and should be continued, noting it is needed even more now given the energy crisis.

- What have been the results in terms of the workforce development program. Do they have any testimonials from those they have assisted?
  - Details of the Department of Education's Workforce Development team support is provided in Figure 10. Investment NSW has introduced 15 manufacturing businesses to this program, who have all accessed elements of the support available.
  - An outstanding example of the support available and provided to Beak & Johnston through initiatives under the Workforce Development program is provided at **Appendix 2.**
  - Additional confidential testimonials have been provided to Investment NSW and can be accessed on agreement from the relevant businesses and Investment NSW.

Figure 10. Details of the Department of Education's Workforce Development team support

Initiative 3

Support the implementation of advanced business models that lead to high-value manufacturing solutions and create products that fulfil previously unmet needs.

- Any testimonials from the supply chain matching program?
  - A testimonial from John Smith, CEO of Smith's BBQs located in Temora NSW, is provided at **Appendix 2**. It highlights the services provided by the Industry Capability Network NSW (ICN), which has been funded by the NSW Government (Investment NSW) for about 30 years.

The Modern Manufacturing Taskforce notes that in this example ICN seems to be working well. There are questions about how ICN could be further improved through greater resourcing, as noted from some of the regional consultations (Clancy, et al., 2022) and through the Q4 2021/22 results showing only 30 manufacturing projects (including 22 Defence projects) were serviced by ICN out of a total of 292 projects.

Initiative 4

Grow exports and attract investment in the NSW advanced manufacturing industry.

- What has been the results of the NSW / India exchange program in terms of new opportunities created?
  - The NSW-India Tech Program was delivered by Investment NSW's Global Network team in 2019/20. Overall, it:
    - » Generated 14 investment leads
    - » Attracted 1005 participants at 12 events
    - » Had 35 total participating NSW businesses in the four trade delegations from NSW
    - » Attracted 1,276 attendees to Minister Ayres's ministerial mission (not including manufacturing businesses)
    - » Generated immediate export sales of $42,000 and projected export sales of over $1.2 million.
  - The Advanced Manufacturing Trade Mission component of the program had:
    - » 4 participating businesses. Its qualitative highlights included:
      - o Improved market literacy and understanding of doing business in India, including opportunities, challenges, regulations etc.
      - o Cultural insights around doing business
      - o Opportunities for networking and promotion
      - o Introductions to potential new customers in India
      - o Training in marketing
      - o Peer interaction with other NSW participants in the cohorts
      - o Coaching from export advisers, business advisory services providers and in-country market team.
    - » Participating business Milspec reported:
      - o Export sale value – AUD 80,000
      - o Projected sales in 12-24 months – AUD 2mn
      - o Jobs created as a result – 10
      - o Services rating – Excellent
    - » The Global Network team continues to work with Milspec via assistance with additional India market meetings and trade shows.

The Modern Manufacturing Taskforce notes that the India Tech Program and Trade Mission statistics are not overly impressive and could be improved with greater resourcing, given the 2018 Advanced Manufacturing Strategy was unfunded. It is also recommended that the High Commissioner, who is a strong advocate, be approached on how we can lift participation in Trade Missions to India and encourage reciprocal trade and investment.

NSW Industry Development Framework

The NSW Government has recently released its Industry Development Framework ('The Framework') (Centre for Economic and Regional Development, 2022). Its vision is to create a business environment conducive to economic growth and social prosperity through industry policy.

'Industry policy' uses targeted government interventions to improve the business environment or shift the structure of economic activity towards sectors or technologies that offer better prospects for economic growth. It operates within the wider set of macroeconomic, trade, environmental and labour market policies, and is one component of NSW Government's broader economic strategy to achieve the best conditions in which industries and firms can thrive.

Moving forward, the Industry Framework will complement existing policies by consistently identifying the right levers for government to use in selected situations, thereby effectively increasing incentives for firms to innovate, scale and lift productivity. Its focused interventions seek to overcome market shortcomings that impede growth in key areas for NSW.

The Framework recognises that advanced manufacturing is a core enabling technology and aims to encourage the uptake of manufacturing in relation to the priority industries through targeted intervention. The Framework is also congruent with our definition of modern manufacturing, in that it aims to create highly skilled and well-paid jobs through increase in productivity.

The Framework has identified a range of policy levers, within the Business Environment Policy Targets and the Principles under the Framework, that NSW Government can pull in order to grow industries, including:

- Strategic public procurement and regulation
- Trade facilitation and promotion
- Vocational training and higher education
- Training grants and wage tax credits
- Investment attraction and facilitation
- Supplier and value chain resilience and development
- R&D incentives, incubators and scale-up programs
- Regulatory reform facilitating industry innovations
- Venture capital, small and medium enterprises (SME) finance schemes
- Cluster models
- Infrastructure development, co-funding and provision

This report aligns the Modern Manufacturing focus themes to the Business Environment Policy Targets or the Principles under the Framework, so that the right policy levers can be identified for each recommendation under these themes (see **Section 4**).

6 Rationale for the recommendations

Coordinated approach

The appointment of the Modern Manufacturing Commissioner provides a unique opportunity to engage in a coordinated approach to priority setting, program implementation and cultural change through an activist industry-facing role. However, this will require a commitment to adequately resource and staff the Office of the Modern Manufacturer.

Manufacturing needs full backing

The incoming Modern Manufacturing Commissioner faces a daunting task. Manufacturing in NSW is at a critical juncture. It will take the full backing of the Government to buck the trend of declining manufacturing activity in NSW over the previous three decades.

The NSW Government is in a unique position to boost manufacturing within the state, and to impact manufacturing in Australia as a whole. However, that can only be achieved with unwavering vision and commitment. The Taskforce welcomes the decision by the NSW Government to extend the term of the Modern Manufacturing Commissioner to a minimum three-year term, and it is recommended that there be flexibility to extend the term further. The Taskforce also recommends that the NSW Government provides sufficient resources to the office of the Modern Manufacturing Commissioner for it to carry out this vital work.

Manufacturing in NSW also faces natural challenges due to Australia's geography and isolation. The Australian market, while significant, pales in comparison next to its crowded neighbours in the Asia-Pacific region. It is difficult for Australian manufacturers to achieve economies of scale, and certainly not the economies of scale that China, Japan, and South Korea can achieve. At the same time, economic reform, economic liberalisation, and the proliferation of Free Trade Agreements have meant that it's much easier to either import goods straight from overseas, or else to offshore manufacturing capacity.

At the same time, manufacturing is now a complex process involving many different moving parts. From skills and labour, to supply chains, to planning, the issues that manufacturers encounter are myriad. There can be no 'one size fits all' solution to those issues, and no single government entity is able to solve them all. The Modern Manufacturing Commissioner must be enabled and empowered to work across the relevant government agencies, and their voice must be heard.

It is the Taskforce's view that the Queensland Coordinator-General can serve as a model for the powers of the Modern Manufacturing Commissioner. The role of the Queensland Coordinator-General was established in 1938 to coordinate the provision of public infrastructure and encourage development and the creation of jobs in the aftermath of the Great Depression. The Queensland Coordinator-General has the power to manage assessments and approvals of infrastructure projects, establish state development areas for industry, compulsorily acquire land for infrastructure development, and facilitate the planning and delivery of infrastructure. The Commissioner should have similar powers when it comes to the development of manufacturing in NSW; the Commissioner ought to be an advocate and problem solver for manufacturers who are planning to start or expand their operations in NSW.

Build upon the foundation

The decline of manufacturing is not a new problem, and there were attempts at reviving manufacturing prior to the commencement of this Taskforce. The NSW Government previously released the 2018 NSW Advanced Manufacturing Industry Development Strategy. The Strategy served as a focus for setting solid foundations for the future of manufacturing in NSW, however, it was unfunded and lacked the capacity to deliver any game-changing impact. Similarly, there have been unprecedented global economic shocks since 2018, in particular the COVID-19 pandemic and the increase in geopolitical instability. In combination, these have seriously disrupted global supply chains. It is time for a reset of the Strategy and a commitment to sufficiently funding it moving forward.

The Taskforce recommends that the Commissioner build upon this foundation and create a new, updated Modern Manufacturing Strategy. In broad strokes, the updated Strategy should be based upon the following principles:

- Focus on state strengths based on the NSW Industry Development Framework, the Industry Development Policy (Securing Future Innovation and Global Competitiveness in NSW), and the NSW R&D Roadmap
- Align to the Commonwealth Manufacturing Statement and Priorities
- Align policy aims and have a consistent and persistent approach to manufacturing in terms of longevity of programs and certainty of long-term funding (cf Flanders Make model)
- Ensure annual evaluation of any programs developed to measure their effectiveness against the original goals, ensuring sufficient time and resources have been applied to reach these goals, and terminate ineffective programs in a timely fashion.

Legislation and regulations are another powerful tool at the disposal of the Government, although its deployment should be carefully considered to avoid unintended consequences. The Taskforce recommends that the impact of every relevant piece of legislation and regulation be considered with the lens of how it would affect manufacturing. As an example, every relevant regulatory impact statement should answer the question 'would this proposal promote or disadvantage local manufacturers?'.

Collaboration

Develop, in collaboration with state-wide research and industry partners, structured co-investment initiatives through a new network of Catapult-like Advanced Manufacturing Research Facility (AMRF) outreach nodes (Hub and Spoke model) in key manufacturing centres around NSW.

University/Industry/ Government collaboration

NSW has many foundational manufacturing capabilities: notably, a highly-educated workforce with Australia's largest group of science, technology, engineering, and mathematics (STEM) graduates; a world-leading tertiary education sector; and an innovative industry sector. The challenge is to connect all these elements on a more permanent basis so that collaboration becomes entrenched.

According to the NSW Innovation and Productivity Scorecard 2022, 'all benchmarked economies continue to outperform NSW for university-industry collaboration, based on university-industry co-authored papers. While NSW's share of research co-authored with industry has grown since the 2019 Scorecard, so too has the rest of the worlds.' (NSW Innovation and Productivity Council, 2022). A radical, lasting change is required to reverse this situation.

In the case of manufacturing, existing collaboration networks in NSW are insufficiently coordinated to achieve radical change.

NSW does have a Small Business Innovation Program and invests in Research and Innovation Networks. Existing networks include the NSW Circular Economy Innovation Network, NSW Smart Sensing Network (NSSN), the Australian Defence Innovation Network (DIN), and the Industry Capability Network (ADIN).

Additional networks planned are:

- NSW Connectivity Innovation Network
- NSW Decarbonisation Innovation Hub
- NSW Space Research Network

The Taskforce proposes that the NSW Government go further and adopt features of the UK Catapult model including additional R&D/ manufacturing test bed type facilities. This will help with the coordination issues identified. In particular, the focus must be on industry-led research and technology that provides an industry problem looking for a solution (pull commercialisation), rather than the traditional linear lab to market approach, which represents a solution looking for a problem (push commercialisation).

There is a consensus that government can play a role in the institutionalisation of innovation involving business, academia, and policy. Sometimes explained as the Triple Helix theory, the ideal collaboration arrangement incentivises the parties involved to innovate in a collaborative way. Government can play a co-investment role, where all the facilities and staff essentially exist in place but there is insufficient justification for one entity acting alone to make the capital investment. A future example could be co-investment in a range of carbon abatement projects that industry and academia could undertake but lack the capital investment to be able to do so (Nowlan, 2021).

The deployment and use of Industry 4.0 technologies typically require collaboration in unfamiliar areas, such as open data or IP sharing. A catalyst may be required, going beyond the notion of co-investment, such as a physical facility for shared use, testing, or enabling policies. Business, academia and government can all play a part in ensuring collaborations of this kind will succeed.

The NSW Government's establishment of the AMRF is one such manifestation of where public funding and policy enables the connection of academia and business. The AMRF offers a physical centre to accompany the networked connections that business and academia will contribute to. As such, it is a critical catalyst but not the entire collaboration solution. A developed solution requires true sharing of opportunities, data, funding and IP to advance the whole ecosystem.

Expanding shared facilities (such as the AMRF) across the state, and nationally, offers smaller businesses additional opportunities to turn ideas into true commercial prospects. Broadening the AMRF model could be achieved using several international models, with the UK Catapult model being one that appears closely aligned to the NSW context. In particular, the UK model utilises certain criteria for identifying 'candidate areas' for new Catapult centres.

Of particular interest are key criteria that if applied to NSW, would identify expansion potential along AMRF/Catapult lines. These were noted by Professor Graham Wren, University of Strathclyde, when consulted for this report, and further detail was drawn from recent reporting on the subject. Key success factors include:

- The technology/sector should have a large projected future global market.
- Industrial capacity should be large enough to anchor significant and high-value parts of the value chain.
- Large companies are needed to act as an anchor, but ideally a large cluster of their suppliers should be nearby.
- Multiple large companies may be less willing to work with their competitors, but there may be areas of common ground that make sharing attractive. Examples include sharing expensive developments such as clean energy/carbon abatement projects.
- There should be strong research capabilities in the area, allowing for a coupling mechanism between research and industry.
- Locations need to be attractive to the talented staff sought. This includes lifestyle considerations likely to attract the most talented experts in their respective fields.
- There should be the potential for spillover benefits to other parts of the economy including from multiple sector effects, regional and technology spillovers, and impact of productivity.
- Ideally the local benefits should foster consent to operate. Being a large employer, or being perceived to be pursuing worthwhile goals, are examples of how consent has developed and grown.

In the case of NSW, we would be seeking to build on strengths by region (such as Fighter aircraft servicing in the Hunter region), or skillset (such as the Welding Engineering Research Group (WERG) in Wollongong) or recognised centre of academic excellence (such as the Australian Centre for Field Robotics).

Using the Catapult model 'rule of thirds' where the investment combination is industry/academia/government there are a number of avenues available to build on such strengths. Examples include:

- Establishing a new facility belonging to an existing research centre, in a new location, and/or
- Expanding the capacity of an existing facility, and/or
- Establishing a new shared facility in an area where businesses have clustered.

In all cases the aspiration would be to establish centres where long-term arrangements can be set in place to meet real world technology/product development needs and accelerate the spread of advanced manufacturing processes to entities that otherwise could not access it.

A critical element of expanding the AMRF through a Catapult model is that new facilities should be physically proximate to skills, industry, or education bases. For example, a geographic industry hub such as Albury is a location well-served by manufacturers and their workforces. A shared service facility would not only be able to grow capability locally, but would also serve as a stimulus for other businesses to cluster in the same area. Over time, there are wider possible effects including diversifying the career opportunities and career paths available in the region – this includes research opportunities in the new facility itself.

Geographic expansion of the AMRF through a Catapult model also takes account of more recent trends in state/national development. These include a general concern about the availability and cost of industrial land in capital cities, and a pandemic-initiated (but lifestyle-encouraged) drift to regional areas. The ability of knowledge workers to work 'remotely' is part of this impetus.

In addition, there are open space requirements peculiar to some forms of manufacturing or R&D. Regional hubs are well-placed to service these needs, particularly when education or manufacturing clusters exist nearby. Increasingly congested airspace/real estate in capital cities is far less suitable for the development of some categories of aerospace vehicles and indeed agriculture or mining applications. Applications intended for urban use naturally require urban testbeds when the technology is mature enough to safely operate there.

Actively seeking external collaborators and running various solution streams simultaneously to maximise potential for success was the driving force behind the successful creation of a fully functioning emergency ventilator to assist with the NSW Government COVID-19 response.

In response to the NSW Government 'call-to-arms' in March 2020, Ampcontrol designed and developed the ventilator in consultation with the NSW Government and project partners NSW Health, Safearth, NewieVentures, University of Newcastle and the John Hunter Hospital.

Employing an agile approach to innovation and calling on the right collaborators with the knowledge required for such a project, a dedicated research & development team (of up to 60 members at one point) successfully delivered an initial functional prototype for testing at the John Hunter Hospital in just 18 days.

See Appendix 3 for the full case study.

Molycop's **long-term and ongoing collaboration** with the UNSW SMaRT Centre shows how economic and sustainability benefits can be born when there is **close collaboration between industry and research** and when they strive towards the same goals – in this case, reducing waste and sourcing sustainable materials for manufacturing. This case study also **demonstrates the need to leverage funding and resources from various partners to reach scale.**

Molycop operates an integrated steel plant at Waratah as well as a waste recovery service located at Cootamundra. The 360-business process recycles mining, industrial, and council wastes into feedstock for their steel-making operations, using Green Steel Polymer Injection Technology® under licence from the UNSW Sustainable Materials Research and Technology (SMaRT) Centre. This uses rubber from end-of-life tyres as the reducing agent in the steel-making furnaces, thus decreasing the amount of coking coal required in the process.

Benefits include reducing the amount of energy required, reducing waste going into landfill, reducing greenhouse gas emissions, improving production efficiency and reducing Australia's reliance on coking coal from overseas.

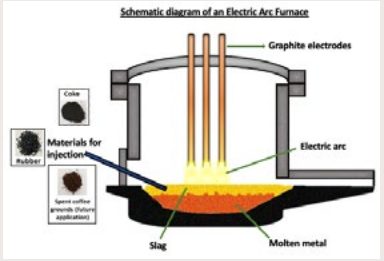
Despite being one of the largest coal exporters, last year Australia imported $151 million worth of coking coal, primarily from China, New Zealand, and India.

The successful trial of using waste materials in the steel-making process, or 'Green Steel', and its adoption into manufacturing, should be **celebrated as an example of research commercialisation done right.**

Leveraging funding and resources from all sources, including the Commonwealth and other state programs, also lies behind the successful development and commercialisation of this technology. The Australian Research Council, through the UNSW SMaRT Centre as host, jointly funded with industry including Molycop, the ARC Green Manufacturing Research Hub at UNSW. The Commonwealth Government provided funding over four years for the Hub, which ran to 2020, while in 2021, the UNSW SMaRT Centre teamed up with Molycop again (along with other industry partners) and successfully secured funding for the new ARC Microrecycling Research Hub. This is highly significant as research and industry are striving towards the same goal of reducing waste and sourcing sustainable materials for manufacturing.

The collaboration between Molycop and the UNSW SMaRT Centre continues and in late 2021 they secured funding from the Commonwealth Government-backed Advanced Manufacturing Growth Centre to help advance commercialisation of SMaRT's 'Green Steel' Polymer Injection Technology as part of SMaRT's next generation research into Green Steel.

See Appendix 3 for the full case study.



Promotion

Promote new entrepreneurial ventures in innovation precincts, building on NSW competitive advantages in digital technologies, quantum technologies, materials science, synthetic biology, artificial intelligence and data analytics.

Promotion of entrepreneurship and start-ups

The start-up model has produced a great deal of success in the last 20 years. Technology companies and their products and services are part of daily life, for good or ill. 'Unicorns', or start-ups that have reached 1 billion USD in valuation, have become household names. We rightfully celebrate the successes of tech start-ups such as Atlassian and Canva, as they show that Australia can keep up with the cream of the crop when it comes to innovation and commercialisation.

Even though most start-ups are in the technology and software space, many require manufacturing and engineering to bring technology to life. Similarly, manufacturing can also benefit from the application of the same best practices. Indeed, during consultations the Taskforce witnessed engineering and manufacturing start-up accelerators achieving good levels of success. The Taskforce wishes for those successes to be further emulated and propagated.

The NSW Government recognises the importance of start-ups and has provided a suite of measures to aid their growth. Some measures include funding the Sydney School of Entrepreneurship, the Sydney Startup Hub, and various grants such as Minimum Viable Product and Tech Vouchers. Most of those measures do not include manufacturing as their core component. The Taskforce recommends that the Commissioner work with existing agencies to promote early-stage entrepreneurship in the manufacturing sector, such as with CICADA Innovations which has a significant group of companies focused on health and medical research commercialisation that frequently have a manufacturing component.

Changing the image and perception of manufacturing

Manufacturing has had its fair share of image issues over the years. As we examine previous industrial revolutions, we were often told of the horrendous health and safety conditions that workers faced. Barely a century ago, factory labourers worked in harmful conditions that would be unimaginable today. Think of the 'phossy jaws' of the girls who made matchsticks, or the radiation poisoning suffered by the 'Radium Girls' who painted watch dials with radium dye. The traditional view of manufacturing can best be summed up by Charlie Chaplin's Modern Times, where our titular character suffers greatly through the monotonous, dangerous, and inhumane work on the Fordist assembly line.

This unfortunate reputation of manufacturing of the past is thoroughly undeserved today. Australia's modern manufacturing industry is safe and well-regulated. The latest statistics on Work Related Traumatic Injury Fatalities for manufacturing was 2 fatalities per 100,000 workers, which is well below industries including agriculture, transport, and construction.

The lingering perception of manufacturing is beginning to shift in national conversations. People are increasingly cognisant of the role that manufacturing plays in the national wellbeing of Australia. The Advanced Manufacturing Growth Centre (AMGC) conducted the Australian Manufacturing Perception Surveys in 2019 and 2021, and the results are positive. 72 per cent of survey respondents in 2021 identified manufacturing as being very important or important to the Australian economy, and 69 per cent of respondents thought that manufacturing is very important or important to the standard of living. 62 per cent of respondents regard products manufactured in Australia as having high standards of quality, 58 per cent would pay more for goods manufactured in Australia, and 48 per cent see Australian manufacturing as globally competitive.

Nonetheless, there are some worrying trends identified in the surveys. Less than half (48 per cent) of young people aged 18 to 24 see manufacturing as important. Australia cannot have a vibrant and innovative manufacturing nation if its best and brightest minds are not interested in manufacturing.

Thus, the Taskforce recommends that the office of the Modern Manufacturing Commissioner plays a Public Relations role, including raising awareness of the association of high-tech, engineering, and emerging and exciting technologies with manufacturing, through marketing and other campaigns.

The trend identified in the Australian Manufacturing Perception Survey is also corroborated by Vocational Education and Training (VET) and university engineering enrolments. Manufacturing has relied on two parallel but distinct skills pipelines; it needs experienced machinists, fitters and technicians from the VET sector, and skilled engineers from universities. Data reveal a mixed bag on the number of people taking up training in those two skill pipelines.

Engineering commencements in Australia reached a peak in 2014, at the very height of the mining boom. The latest Engineers Australia data is from 2018, where 18,855 people commenced a degree in engineering. This is on par with the level of commencements in 2010 and 2011. Encouragingly, even though the number of engineering commencements have not scaled their former heights, there was an inflection reached in 2017 and commencements are now trending positive.

TAFE and vocational education statistics on engineering paints a similar but slightly rosier picture. Data prior to 2015 is not available, but there has been considerable interest in engineering, with commencements peaking in 2019 at 83,764 and only decreasing slightly in 2020 to 78,943.

The period immediately after the HSC is a time of considerable change for many school leavers. Thus, the Taskforce recommends that the NSW Government commence multimedia advertising campaigns to promote the studying of engineering in TAFE, other RTOs, and universities to school leavers after their HSC exams.

Thus, the Taskforce recommends that the NSW Modern Manufacturing Commissioner develops programs that raise awareness in school students of the opportunities in modern manufacturing and entrepreneurship (for example the Cyber Security Ambassadors program model).

Procurement

Stakeholder consultations acknowledged the value of winning and retaining work compared to the value of grants, loans, or other assistance programs. It is in this respect that a single NSW Government agency would have potential to exert positive influence on the manufacturing landscape through the application of procurement policies that appropriately utilise local suppliers.

The economic benefit to NSW of buying locally also includes benefits to government, such as increased payroll tax and the multiplier effect of spending locally. Including an overall benefit test in the pricing model that looks beyond price may be a way to overcome concerns regarding local procurement provisions.

Current procurement guidelines in NSW are fully compliant with the various free trade agreement regimes and naturally prioritise value for money in acquisition decisions. While there is no intent to change this, stakeholders suggest that the value for money calculations/formulae should include consideration of other factors such as local manufacture, sustainability, capability development, sovereign IP retention and jobs, placing more emphasis on the value of local supply and other spillover impacts. The Taskforce concurs and proposes that the assessment methodologies that are decided upon should be publicly available to help local manufacturers better articulate the overall value of their bids to NSW.

While it may be impractical in the short term to mandate a 'local content' regime, the Taskforce considers that the 'value for money' equation can be immediately reviewed to ensure that manufacturing sustainability/capability development is carefully considered as part of procurement decisions.

However, Commonwealth policy changes from mid-2022 suggest that additional measures to promote local procurement could also be taken. In mid-2022, the Commonwealth Finance Minister announced revisions to Commonwealth Procurement Rules (CPRs) to expand opportunities for SMEs to supply the Commonwealth. From 1 July, the Commonwealth government will source at least 20 per cent of services from SMEs, as a measure to grow local businesses and employ more staff (Coade, 2022). A new value-for-money principle will inform how public servants determine procurement proposals, including a feature to prompt consideration of climate change impact. The Commonwealth described this as the first step in a 'Buy Australian Plan', with more details yet to be announced.

Apropos of the Commonwealth's inclusion of climate change impact in procurement decisions, manufacturers are concerned that they will be disadvantaged by investing in greenhouse gas (GHG) emissions reductions. Particularly in the case of steel-making, the overriding stakeholder concern is that procurement – and indeed other – policies do not disadvantage Australian industry compared to high-emitting but lower cost competitors (Nowlan, 2021).

The revision to CPRs to integrate climate change impact in procurement decision-making demonstrates that price does not need to be the sole factor in assessing value for money, and that other relevant considerations can be mandated. Under the new Commonwealth rules, procurement officials must show they have considered each submission against a list that includes quality, fitness for purpose, a supplier's relevant experience and performance history, environmental sustainability of the goods and services, and whole-of-life costs. Clearly the addition of criteria related to the sustainability of local manufacturing is possible.

Working with the Commonwealth and aligning procurement policies across both levels of government would be further beneficial to manufacturers, avoiding confusion and unnecessary complication in applying for tenders. Being able to develop bids that can be recycled and used at different levels of government would also reduce red tape and streamline time and resource commitment for manufacturers.

Concurrent with the review of value for money calculations, it is considered timely to also review the complexity of various panels and tender arrangements. Ideally, NSW Government agency support should be available to guide local manufacturers to the most suitable panels to maximise their chances of participation; this would also allow stakeholder perceptions of a multitude of panels to be addressed.

Also worthy of consideration for consolidation are the procurement tensions that arise between states of the Commonwealth when each is developing infrastructure independently. That each state develops plans in isolation and may not issue long-term planning guidance, are factors that work against Australian companies supplying heavy equipment such as railway rolling stock. Stakeholder experience (Fenn & Kakavas, 2022) reveals that individual Australian companies have the capability to design, build and deliver rolling stock but are not given long-term commitments of the nature that would allow them to invest in the resources and infrastructure to support globally competitive future production. In addition, the market for individual states is far less significant than the potential market covered by the entirety of Australia. Stakeholders have advised that the Australian market is of sufficient size to support ongoing investment from them into this space, but only if long-term planning and a commitment to local production is provided at a national level to support investment returns.

Establishing a long-term procurement plan for state infrastructure such as rail makes available an additional lever to government to establish regional manufacturing hubs where it makes sense. For example, if the Government is procuring heavy rail, solar panels, and/or batteries for state infrastructure, then a preference for regional manufacturing or assembly may encourage the establishment of new facilities and supply chains in regions where this may be most socially and economically beneficial.

The single agency described elsewhere in this paper as a 'one stop shop' would ideally be capable of guiding manufacturers into the correct assistance programs and supplier panels, while also at a minimum playing an active role in evolving the procurement system into a more state-focused entity. A combination of industry experienced advisors in client-facing roles and policy officers with a deep understanding of sovereign industry development (and the associated economic issues) would be the ideal staff to assist the development of such procurement policies.

Lithgow Arms

This case serves as an example of a situation **where a NSW manufacturing capability was not supported during the NSW procurement process**. It is acknowledged that normal procurement processes will have been applied and a choice made to ensure value for money. The value for money equation for the state is less clear, noting the potential for local manufacturers to be lost to NSW if they are unable to secure local sales.

In 2017 Lithgow Arms was Australia's only domestic small arms factory, and this is still the case in 2022. In 2017, Lithgow Arms offered Australia's only domestically-produced police rifle, but an import (the M4) was selected. Over 2014-17 alone, Thales Australia had invested over A$4 million to build the capability of the site, and prior investment in the family of rifles went back to 1988. The family of military/police rifles made in Lithgow (variants of which are called the Enhanced F88 or EF88) dates back to the 1980s but has undergone a series of design and manufacturing improvements. Rifles like the EF 88 or F90 LE are based on an Austrian design by Steyr, but are now 95 per cent Australian content.

Each instance of a contract being awarded offshore when an equivalent product is made in Australia, as in the case of the M4 procurement, represents a weakening of the case to continue local NSW investment in R&D and factory modernisation. This is particularly the case for companies that have options available globally.

Conversely, local procurement applied judiciously is a powerful incentive for local manufacturing to continue R&D and expansion, with flow on effects to supply chains and quality local jobs.

See Appendix 3 for the full case study.

With the investment GME has already made into P25 Phase 1, and the common response by governments of requesting Phase 2 even when there is no plan to migrate to Phase 2, **raises the question of whether any level of government in Australia would be willing to support a sovereign NSW-developed and manufactured** P25 Phase 2 product if GME were to consider investing in this radio technology.

GME commenced developing a P25 radio solution more than 10 years ago, and have invested heavily over the years in R&D and engineering to ensure continuous improvement. The result of GME's investment is the CM60 range of P25 Phase 1 radios. It is the only P25 radio designed and manufactured in Australia.

GME has received recognition of the CM60 P25 radio capability and compliance both here in Australia and overseas. In Australia, GME has successfully bid for supply of radios to the Ergon Energy network. In the United States, the GME CM60 has been approved for supply to both the Department of Homeland Security and the Department of Interior (DOI) supply panels, including a data variant of CM60 which was specifically designed to meet DOI requirements. GME was the only company who successfully achieved this requirement.

The GME CM60 operating in P25 Phase 1 has successfully passed all requirements set out in the NSW GRN Subscriber Unit Call Testing document. While all tests were successfully completed, GME is still not approved on the NSW GRN due to lack of Phase 2 capability, even though most areas of New South Wales do not require Phase 2.

See Appendix 3 for the full case study.

Targeted support

Develop targeted business support programs in designated priority areas to build management and enterprise capability in global markets and value chains, with emphasis on enterprise absorptive capacity and circular economy.

Rationalise existing measures

There are numerous existing government aims and measures meant to help our local manufacturers. Whilst well meaning, they are difficult to navigate and onerous to qualify. The programs themselves are also administered by various departments without a central co-ordination agency. It makes information dissemination to SMEs more difficult due to the diffuse nature of those programs.

There is merit in an exercise reviewing the number and nature of support programs available to SMEs, and especially for local manufacturers, identifying who administers those programs, how much funding is available, and when those programs close. The performance of all programs should be reviewed on an annual basis as a condition of government support. The evaluation should include their effectiveness at growing manufacturing in NSW. This exercise was not conducted by the Taskforce due to time constraints, but it should serve as valuable data for the incoming Commissioner.

It is the view of the Taskforce that existing state government administered programs should be consolidated where possible, retired when they are not performing, and have their commitment extended if appropriate. The Commissioner should also investigate the possibility of leveraging existing industry and professional associations in delivering those programs.

Targeted support – one stop shop

Stakeholder consultation revealed that the variety of Commonwealth/state support packages available to manufacturers is not always readily understood, nor is the application process always considered a productive use of resources. Due to the complexity of processes, uncertainty of outcome and the time required to achieve a decision, the opposite is often held to be the case.

There are currently around 150 government grants and funding programs targeting Australian manufacturers (Industry Update, 2022). This suggests that the programs themselves would benefit from review and simplification. The Taskforce is not recommending adding to the number of programs, but rather rationalising with a focus on the themes identified.

Stakeholders have proposed some form of 'one stop shop' or concierge service be developed to help manufacturing businesses better understand, navigate, and access the many Commonwealth/state programs, as well as to shepherd them through difficult government services such as planning, procurement, education and training, and regulation. The concierge service will be vitally important to start-ups and established players alike.

As a short-term expedient, it should be possible to offer client relationship management to assist businesses in achieving the support packages and services most relevant to their needs. Such a measure would most likely be short-term, because of the cost involved in providing experts with the necessary industry/state/Commonwealth government knowledge and experience to many applicants. The Taskforce agrees with this approach and proposes the establishment of the **Modern Manufacturing Support Agency** to sit within the Office of the Modern Manufacturing Commissioner.

In the longer term, this type of support service may more appropriately sit with industry associations, and ideally would be accompanied by a reform of the various government offerings to change the perception that they are inaccessible. Industry associations have the benefit of extensive experience in their geographic area and/or industry sector as well as other characteristics that position them well to provide expertise to applicants. These characteristics include:

- Knowledge of the regulatory environment peculiar to sectors (such as pharmaceutical manufacturing, zero emissions vehicles, Defence contracting, etc.)
- Long-term knowledge of industry sector developmental needs
- Long-term connections with state and Commonwealth departments involved in manufacturing (though it is hoped these will be simplified over time into a one stop shop).

The terms 'concierge' and 'one stop shop' may be slightly outdated in that they do not tell the full story of the assistance required. The terms have connotations of process-oriented direction of any applicant to an immediate solution. In fact, the success of a support service will depend on well-designed programs and very experienced advisors who have the capability to provide practical advice to applicants. In most cases, the solutions will not be immediate, though a clear pathway to guide applicants through problems or issues – or several iterations of a solution – should be evident.

As an aid to the appropriate support staff, it is considered timely to offer updated web tools such as the Business Grants Portal used by Singapore. In Singapore, this is a cross-agency portal offered by the Ministry of Finance, Ministry of Trade and Industry and Government Technology Agency. It is like the functionality offered by the Service NSW website, and therefore ought to be straightforward to implement for manufacturing related grants.

Leveraging Commonwealth funding

It is envisioned that the Modern Manufacturing Support Agency would also aid businesses who wish to take advantage of Commonwealth funding programs. Feedback that the Taskforce received was that government grants and funding opportunities at all levels were quite onerous to apply for. No doubt a measure of precaution is warranted to prevent rorts,

but it presents an obstacle for business to access government grants, especially for smaller businesses who are not as well-resourced as their larger competitors.

We are not suggesting we help businesses write their own grants.

When the Commonwealth released its funding allocation under its Modern Manufacturing Fund in rounds 1 and 2, Victoria took the lion's share in both rounds – for both large and small companies.

There are several measures that the NSW Government could take to improve its state's share of successful Commonwealth manufacturing grants:

- Better communication and dissemination of when funding rounds open. This would entail maintaining close contact with the Commonwealth team administering the fund, and liaising with our partner networks to get this information to manufacturers.
- Run workshops on how to write a grant application, and how the grant application works. This could apply to both Commonwealth administered grants and NSW administered grants, developing capabilities in the businesses at the same time.
- For the consideration of the Commissioner – develop a matched funding program, where businesses would get matched funding from the NSW Government if they were successful in obtaining Commonwealth funding. An example of a successful co-investment model that can leverage Commonwealth funding is the Research Attraction and Acceleration Program (RAAP).

The RAAP program is administered by the NSW Office of the Chief Scientist and Engineer, aimed at leveraging Commonwealth grants for scientific research. The NSW Chief Scientist would draft letters of support for universities within the state, promising to match investment should the university be successful at securing Commonwealth funding. It makes the proposal from prospective universities more favourable to the Commonwealth and minimises risk. The RAAP has been very successful, and several ARC Centres of Excellence have now established themselves in NSW.

Refining and expanding support measures

The Taskforce notes that the Commonwealth increased the R&D Tax Offset for companies from 1 July 2021. We applaud this decision and believe that it is a step in the right direction. We recommend the NSW Government also advocate for a tax offset for investors, particularly into SME manufacturers and those looking to develop and implement Industry 4.0 innovations.

There are other additional measures that the NSW Government can take to increase the capacities of local manufacturers. It became apparent in the consultation process that SMEs may lack the resources to undertake steps in transforming their business into an Industry 4.0 business model, or the adoption of Industry 4.0 technologies. The will is there, but government is needed to lead the way. One way is for the NSW Government to facilitate the rolling out and adoption of the Smart Industry Readiness Index (SIRI). The Smart Industry Readiness Index (SIRI) was created by the Singapore Economic Development Board (EDB) in partnership with a network of leading technology companies, consultancy firms, and industry and academic experts. It is now administered by the International Centre for Industrial Transformation (INCIT). SIRI provides companies with a framework of self-assessment in their Industry 4.0 capabilities and guides how to achieve Industry 4.0 transformation.

There are other Singaporean models that could serve as inspiration for NSW. Singapore's SME Go Digital program is an excellent platform for SMEs to adopt digital strategy. The Singaporean program includes offering Chief Technological Officer (CTO) expertise as a service, providing SMEs with pre-approved digital solutions, and leveraging Business-to-Business (B2B) and Business-to-Consumer (B2C) platforms to help SMEs export overseas without the need to set up a physical presence. Many of the features listed in the Singaporean program will fit businesses in NSW quite well and should serve as a basis for a similar program to be established by the Commissioner.

Lindfield Collaboration Hub

"Hardware is very different to software and so access to the Maker Space has been great. That has let me get started without having to buy my own equipment in a lot of cases."
–[CSIRO Lindfield Collaboration Hub]

"You need somewhere where you can do your prototype manufacturing and your R&D, and that's what Lindfield's perfect for."
–[CSIRO Lindfield Collaboration Hub]

"Having access to other founders, you have a camaraderie there because you're all sharing the pain, so to speak."
–[CSIRO Lindfield Collaboration Hub]

"It's a very collaborative and free-thinking environment, and that's the most important thing about it."
–[CSIRO Lindfield Collaboration Hub]

" ...You couldn't write a better story... the quality of the laboratories and access to CSIRO scientists in the physics field has been critical...Lindfield also has the only distance range for calibrating LiDAR in Australia..."
–[CSIRO Lindfield Collaboration Hub]

"Being a part of the group of scientists, engineers and entrepreneurs at CSIRO Lindfield gives our Movandi Australia team camaraderie, support, and access to facilities and social events they would not otherwise have. From a technology perspective, we benefit greatly from having access to an anechoic chamber, RF test equipment and technical experts steps away from our office."
–[CSIRO Lindfield Collaboration Hub]

This case study provides an example of how **targeted public sector support** and **leveraging funding and resources from a variety of partners,** along with significant **industry, research and government collaboration**, can achieve outstanding results in the commercialisation of new technologies, using a solution-driven approach.

Lindfield Collaboration Hub is an innovation incubator, supporting start-ups and SMEs to develop unique high-tech products and devices. Early stage and established companies can access the Lindfield facilities, science know-how, experience, business networks and commercialisation savvy – including CSIRO's ON Innovation team to deliver bespoke commercialisation programs to support the development of emerging ideas and technologies.

The Lindfield Collaboration Hub occupies ~1300m2 of laboratory and office space and is currently home to seven small businesses who employ a total of 50 staff. The Hub also comprises a dedicated Maker Space, which is fitted out with mechanical and electronic tools and equipment to support the fabrication, development and testing of prototype devices.

The Hub has been operating for seven years, and over this time, more than 30 businesses employing >300 staff have co-located at Lindfield across a range of industries and technologies including medical devices, communications, energy, and robotics. The Hub also supports entrepreneurs and innovators to refine their value propositions and business model through commercialisation and innovation programs, such as the NSW Governments Boosting Business Innovation Program, Connect@Lindfield, and building networks through events and workshops.

Example businesses thriving thanks to the Hub include:

- Baraja Pty Ltd – working on a breakthrough LiDAR technique that creates an elegant solution to complex problems.
- operations to keep team members safe and reduce downtime.
- Defy-Hi Robotics – incorporating a window cleaning robot into their operations to keep team members safe and reduce downtime.
- Adiona – winners of the second Innovation District Challenge, developing innovations to tackle the many challenges of COVID-19.
- Innovate to Grow – Advanced Manufacturing – a collaborative program with NSW Government for manufacturing SMEs to refine their innovation ideas and develop a future R&D opportunity.

For more information on the Lindfield Collaboration Hub contact Katie Green katie.green@csiro.au or visit https://research.csiro.au/lindfieldhub/

See Appendix 3 for the full case study.

State and Commonwealth cooperation

Federation impacts the way states and territories compete for Commonwealth and private sector funding and resources. A focus on regional capabilities and strengths, with a future-focused agenda (such as the renewable energy transition) should be the primary drivers of investment, rather than a 'who has the biggest state cheque book' approach.

Enhanced cooperation and cost-effective integration, where appropriate, of state and Commonwealth industry programs will help avoid sub-scale duplication and fragmented efforts, including in the challenge of knowledge-based Foreign Direct Investment (FDI) attraction.

In addition to building efficiencies into industry programs and attracting FDI, we are now in an era of disrupted international trade and geopolitical tension, with supply chain resilience becoming a much greater priority to ensure Australia can meet the needs of its own citizenry. The Taskforce notes the difference between resilience and sovereignty: resilience can include supply chain connections with trusted and proven international partners through secure transport routes, whereas sovereignty requires in situ production and materials supply. Sovereign supply chains may not be most economic, but they have a higher purpose.

Supply chains and Commonwealth policies

Supply chain resilience came into prominence in the wake of the COVID-19 pandemic, which has caused huge disruption worldwide and is still having significant impacts today. Governments around the world restricted individual and commercial activities to contain the spread of the virus. These measures, along with some very large shifts in patterns of demand, have strained global supply chains.

In the early phases of the pandemic, Australia experienced delays and difficulties in sourcing products from overseas. For example, as factories in China and elsewhere were shut or severely reduced in capacity, there was a pronounced shortage of personal protective equipment (PPE) and medical equipment. Demand patterns also shifted during the pandemic. As more and more people started working from home, demands shifted from services to goods. International shipping became much more expensive due to increased demand, a shortage of shipping containers, and congestion at ports.

The Reserve Bank of Australia found that manufacturing was the industry most impacted by supply chain issues, with SMEs heavily affected. Companies have adjusted in the face of disruptions, with measures such as increasing lead time in orders, stockpiling inventories, and finding alternative suppliers.

Geopolitical tensions have also increased the risk to Australia's supply chains. At a strategic level, exposure to market-level risk becomes more prominent. To put it plainly, when the whole market for a particular good or product is at the risk of production, then alarm bells should be ringing. One especially pertinent example is semiconductors. Semiconductors are used in virtually all electronic devices. Crucially, they are also used in almost all weaponry systems and platforms in defence and security apparatus. The COVID-19 pandemic and the subsequent disruption, US-China tensions, and the Russia-Ukraine war has meant that the global shortage in chips is now extending into its third year.

Worryingly for Australia, we have no self-sufficiency at all in the semiconductor industry. Australia has no fabrication plants onshore. China is the top supplier of semiconductors to Australia, having supplied 83 per

cent of semiconductor imports to Australia in 2020. China's unique role in Australia's supply chain and uncertain geopolitical future means that supply chain issues may become quite serious in the future.

Commonwealth and state governments have become aware of the issues posed by supply chains. The recent Commonwealth Senate Inquiry into manufacturing in Australia addressed in part the issue of industry mass or the presence of manufacturing businesses in numbers. In his additional comments to the Inquiry report, Senator Rex Patrick noted 'As manufacturing companies fail, it makes it harder for other manufacturers to operate. Conversely, as manufacturing grows, it makes it easier for other manufacturers to thrive.' (Australia Parliament Senate Economics References Committee, 2022)

The Commonwealth Government has developed new Critical Technology Supply Chain Principles. These Principles will be non-binding and voluntary and are intended to act as a tool to assist governments and businesses in making decisions about their suppliers and the transparency of their own products.

There are ten principles built around the three pillars of security, transparency, and autonomy.

Security should be a core component of critical technologies. Organisations should ensure they are making decisions that build in security from the ground-up; ensuring security is embedded into products and services at design stage. This is a process of building in appropriate security to protect systems and end users from threats and vulnerabilities.

Transparency of technology supply chains is critical, both from a business perspective and a national security perspective. Being transparent means explaining clearly to customers what security measures have been taken, which will reduce uncertainty and increase consumer confidence when purchasing products. Transparency is a key factor in any organisation's ability to manage risks. Understanding your suppliers and networks ensures your organisation is aware of these risks, can identify bottlenecks, and then determine alternative sources of critical inputs when required.

Autonomy and integrity involves knowing that your suppliers demonstrate integrity and are acting autonomously, which is fundamental to securing your supply chain. Autonomy and integrity enable an organisation to operate at its own direction and according to its own drivers, as well as without undue external influence that may jeopardise the security of its products or services.

The Productivity Commission also tabled a report on Vulnerable Supply Chains in June 2021.

The Commission has developed a framework to identify supply chains for goods and services that are vulnerable to disruptions and whose absence would jeopardise the functioning of the economy, national security, and Australians' wellbeing.

Taken together, the analysis offers suggestive — but not conclusive — evidence that many essential goods and services do not depend critically on vulnerable imported inputs. The main supply chain disruption risks that could be problematic arise from the reliance on concentrated imports of some basic chemicals, or some personal protective equipment. For example, the supply of face shields, isolation gowns, polyethylene aprons, and surgical cloths that are predominantly used in health industries were found to be vulnerable.

Similarly, government has a responsibility to manage risks in supply chains for which they purchase and deliver goods and services directly. Key strategies used to prepare for supply chain risks include accepting the residual risk (no action), stockpiling, supplier or market diversification, contingent contracting, and developing domestic capability. Several strategies are likely to be required to mitigate upstream risks.

Essential industries were found to have used 130 vulnerable imports in production. However, many of the vulnerable products, such as textiles (excluding personal protective equipment), are unlikely to be critical to production in these essential industries. This suggests that the production of essentials is not highly susceptible to short-term disruptions in the supply of imported goods that come from concentrated sources.

The main supply chain risks lie in the use of vulnerable chemical imports in health (human medicine manufacturing), energy (petrol and coal product refining), semiconductors, fertilisers, and water treatment industries. Some of these chemical products may be critical.

Sovereign Manufacturing Capability Plan (SMCP) Tranche 1 and Tranche 2

In October 2020, the Commonwealth Government announced a $1.5 billion investment in the Modern Manufacturing Strategy (MMS). From this investment, the government has allocated $107.2 million to address vulnerabilities across supply chains for critical products.

The SMCP have identified products in the following areas as essential:

- Biopharmaceuticals (medicines)
- Agricultural production chemicals
- Personal protective equipment (PPE)
- Semiconductors
- Water treatment chemicals
- Telecommunications equipment

The Supply Chain Resilience Initiative provides up to $2 million to establish or scale a manufacturing capability or a related activity to address supply chain vulnerabilities for a critical product or input identified in the Sovereign Manufacturing Capability Plan. Round 1 has already been concluded, with NSW companies receiving $13 million in grants for manufacturers in biopharmaceuticals and agricultural production chemicals.

It is the Taskforce's wish to see that there is greater cooperation between the state and Commonwealth when it comes to the National Reconstruction Fund, its key priorities, and critical products such as semiconductors. Semiconductors are an essential part of the technology that we have taken for granted and are vital for national security. Australia must have a secure supply of semiconductors. It is the Taskforce's view that the Commissioner should liaise with the Commonwealth and other relevant bodies to investigate the feasibility of producing semiconductors onshore. It is recommended that the Head of Division Technology and National Security, at the Department of Industry, Innovation and Science (DISR), be consulted on this topic.

Foreign Direct Investment

Regarding the issue of attracting modern manufacturing R&D intensive FDI to NSW, there is some concern that excessive overt competition between the Australian states has distorted the FDI market. The overall recommended approach is that FDI should be drawn to Australia, and NSW, based on competitive advantage. It should not devolve into a zero-sum game of cheque book courtship.

As has been noted elsewhere in this report, NSW has many competitive characteristics: notably a highly educated workforce with Australia's largest group of science, technology, engineering and mathematics (STEM) graduates; a world-leading tertiary education sector; and an innovative industry sector. If an investor has decided to invest in Australia, we feel that the most rational approach is to encourage them to seek out the location with characteristics most appropriate to their needs. Ideally, this should be the combination of talent, industries, population, supply chains, agglomerations and real estate. In the case of manufacturing, with proper development over time there should be a suitably strong case for FDI to be attracted to NSW.

It is in this respect that enhanced cooperation between states and the Commonwealth provides an opportunity to encourage direct investment towards the most appropriate state, city, or region. This approach has the advantage over time of building on a successful ecosystem rather than attempting to create a new one from a low (or no) capability base, as well as being able to build globally competitive scale nationwide.

Promotion of NSW capabilities through initiatives such as investor familiarisation visits is a relatively low cost means of promoting manufacturing related capabilities and locations. The opening of high-profile facilities such as the AMRF will assist the investment attraction process by providing an anchor point for group familiarisation tours or individual investor visits.

Certainly, the matter of applicable tax regimes is relevant as far as attracting business to Australia generally is concerned. There may be circumstances where NSW, or other states, feel that some additional financial lever (such as an additional rebate to complement a Commonwealth offset or rebate) to encourage manufacturing in one sector or another is worthwhile.

However, it is important to recognise that the levers available to state governments are not limited to financial grants or incentives. Potential investors may be motived by the availability of funding, of labour and of land in different combinations depending on needs.

The ability of states such as NSW to attract FDI for manufacturing purposes is dependent on an ability to identify the critical levers that are applicable to one sector or another and promote these accordingly.

In the case of manufacturing that needs space, there may be a natural attraction to regional areas of NSW. In the case of medical technology or pharmaceuticals manufacture, it may be a precinct such as Westmead.

In all cases, if government involvement is instrumental in some way to bringing an investment to NSW, then it must be an investment that can endure and provide a return. Like the conditions that apply for the establishment of Catapult style centres, there are elements that will characterise an enduring investment, including:

- Investment should be related to a manufacturing project that will service a large projected future global market.
- Investment in manufacturing capacity should be large enough to anchor significant and high-value parts of the value chain.
- Large companies should act as an anchor for a manufacturing ecosystem, but ideally a large cluster of their suppliers should be nearby.
- Multiple large companies may be able to work with or near their competitors if there are areas of common ground that make sharing attractive. Examples include sharing expensive R&D facilities servicing multiple large investors in Defence projects.
- There should be strong research capabilities in the area, allowing for a co-investment mechanism between research and industry.
- Locations need to be attractive to the talented staff sought to realise the investment. This includes lifestyle considerations that will allow the investor to maintain a productive investment.
- There should be the potential for spillover benefits to other parts of the economy including from multiple sector effects, regional and technology spillovers, and impact of productivity.
- Ideally the local benefits should foster consent, or social licence, for the investor to operate. Being a large employer, or being perceived to be pursuing worthwhile goals, are examples of how consent, or social licence, has developed and grown.

Conversely, the absence of such success factors runs the risk of establishing investment that is only profitable while being continuously supported by government – or remains volatile and likely to be withdrawn at any time. Political will alone will not be a driver of a successful outcome in the long run.

Silicon Quantum Computing

This case study highlights a high-profile example of how **leveraging funding and resources from all sources, including the Commonwealth and state Governments,** can lead to world-leading technology and local manufacturing. It is also an example of a high-tech, cutting-edge company that **is heavily investing in their skills and talent pipeline, from Year 10 level up**, and an example of how **providing targeted business support with commitment** has enabled SQC to achieve world-leading milestones years ahead of international predictions.

SQC was formed in May 2017 by the Commonwealth of Australia, UNSW Sydney, Telstra, CBA and New South Wales Government, to develop a quantum integrated circuit. In addition to funding the 5-year technical development program, the investment was used to acquire a portfolio of intellectual property (IP) developed over the previous 20 years through Commonwealth supported research undertaken in the Australia Research Council Centre of Excellence for Quantum Computation and Communications Technology (CQC2T), headquartered at UNSW Sydney.

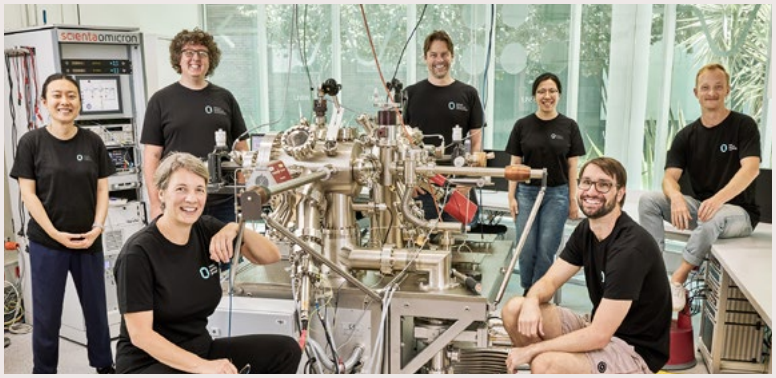
SQC's global advantage lies in its ability to manufacture high-quality quantum processors using atomic-scale components. No other company worldwide has yet been able to match this capability. Moreover, this precision is matched with a fabrication cycle that takes only 2 weeks – at least 10x faster than any competitor.

From a manufacturing and industry-establishment perspective, the delivery of the world's first integrated circuit fabricated at the atomic scale is hugely significant. SQC's chip hardware team are world leaders. With targeted support, SQC could be the first to deliver high-value quantum computing services to a global marketplace from an Australian manufacturing base.

This provides a unique opportunity to manufacture here in Australia, where SQC is uniquely positioned. SQC's global leadership in atomic-scale device manufacturing, the high value and sophistication of its products, and the advantages in integrating hardware, software, and service delivery via the cloud mean that SQC can manufacture competitively from Australia.

SQC's belief in the value of selling globally while manufacturing locally is demonstrated by its commitment to supporting local supply chains and skilled workforce development. Since its establishment, SQC partnered with Sydney technology firm, Silex Systems Ltd, to secure supply of its feedstock, isotopically pure silicon 28. It is also actively addressing talent gaps in key manufacturing and software skills by upskilling graduates from related disciplines and has supported the development of a quantum computing online course for Year 10 students aligned to the Australian curriculum.

See Appendix 3 for the full case study.



Skills and talent

One of the most vital themes discussed during the consultation process was the need for skilled workers in Australia. It was the singular concern shared by all parties. If modern manufacturing is a living, breathing person, then a skilled workforce is the lifeblood. Without a skilled workforce, modern manufacturing in NSW would wither and die on the vine.

There are two areas of focus for a skilled workforce: attracting talent from overseas and developing talent locally. The Taskforce has made a suite of recommendations to cover both focus areas.

Attracting skilled workers

Australia has been a nation of migrants since European settlement. Australian migration policies have emphasised skilled migration and economic development ever since the Second World War, with the most famous example being the Snowy Hydro scheme, where migrants accounted for over 65 per cent of the workforce. Skilled migration recorded strong growth since the turn of the millennium, with successive governments recognising the need for skilled workers to grow the Australian economy. Moreover, skilled migration has taken on a regional development focus as well, as the Commonwealth Government offers incentives for skilled workers to settle in regional Australia.

However, over recent years, the intake of skilled migration has fallen quite dramatically. The number of visas granted has been gradually declining since 2013/14, when Australia issued 128,550 visas to skilled workers. This was further exacerbated by COVID-19 and border restrictions. In 2020/21, the number of skilled worker visas issued stood at 79,620, the lowest it has been in 16 years.

The number of visas issued under Employer Sponsored, State/Territory Nominated and Regional categories have all been declining steadily since records began in 2011. Such a trend is detrimental to manufacturing, where employers across the board are finding it difficult to attract all levels of talent.

Thus, we recommend the Modern Manufacturing Commissioner make strong representations to the Commonwealth with regards to the number of visas issued for skilled migration workers. There are strong labour demands in the post-pandemic world, and with Australia's natural endowments, secure political environment and handling of the pandemic, it is an attractive destination for workers.

Skilled workers who have immigrated to Australia need support as well. Surveys and studies (Engineers Australia, 2021) have repeatedly found that skilled workers from overseas often find it difficult to navigate the Australian labour market and the domestic environment (schools, securing accommodation etc.). Thus, it is important to provide orientation, logistics and follow-up support to these internationally sourced workers so that they can obtain roles that suit their skills and settle their families accordingly. There are several community organisations already dedicated to helping migrants; increased collaboration between the NSW Government and community organisations can provide more consistent and welcoming engagement to better support skilled workers.

Education

Mathematics

Mathematics is the foundation for all engineering subjects taught at universities. In engineering, the interpretation and solution of problems requires the application of mathematical models. To make use of those mathematical models, it is often necessary to use a combination of tools in multiple disciplines of mathematics, including statistics, linear algebra, and differential and integral calculus.

Such is the importance of mathematics to engineering that all engineering students in NSW must take courses in mathematics and statistics in their first two years of study. Specialised streams of engineering require additional mathematics subjects, such as discreet mathematics and finite mathematics. Because mathematics is needed at the tertiary level, we must ensure that mathematics education at primary and secondary level suitably prepares students.

Sadly, Australia is slipping down the ranks both in terms of mathematics education and the level of numeracy in students. OECD's Programme for International Student Assessment (PISA) is a triennial survey of 15-year-old students that assesses how they have acquired the key knowledge and skills essential for full participation in society. Performance in mathematics has been declining since 2003; more worryingly, this decline has been observed in the whole student population that had entered the survey, suggesting there are systematic issues in mathematics education in Australia. Australian students are slightly above average in terms of obtaining basic numeracy; 78 per cent of Australian students obtained Level 2 in PISA mathematics, compared to the OECD average of 76 per cent. However, only 10 per cent of Australian students obtained the highest possible Level 5 achievement. This is below the OECD average of 11 per cent and is far behind other jurisdictions in the Asia-Pacific region.

Mathematics in the HSC

The number of students taking mathematics for their Higher School Certificate (HSC) has declined over the last two decades. One quarter of Year 12 students did not take any level of mathematics in the HSC in 2019, compared to just 6 per cent in 2000. Of the students who did enrol in a mathematics subject, only about 30 per cent are taking calculus-based mathematics.

The NSW Government is in the process of making mathematics compulsory for all HSC students; a policy that was announced in 2019. The Taskforce welcomes the direction that NSW has taken in relation to mathematics education in the state, however we believe that more is needed. We call on the NSW Government to make representations to the University Admission Centre (UAC), which oversees scaling subject scores in calculating the Australian Tertiary Admission Rank (ATAR), to scale mathematics subjects to be more competitive in attaining higher ATARs. Since mathematics is an essential skill not only for academic study but for life, it is important that all levels of mathematics should be scaled accordingly in calculating the ATAR.

Primary school teachers

It is also imperative that all primary school teachers should have the adequate numeracy skills for teaching mathematics at this level. As primary school teachers teach students on a range of subjects, it is appropriate that they have the adequate toolset to prepare students for a lifetime of learning and to kindle their interest and curiosity in such an important subject. The Taskforce notes that mathematics teaching is included in various curriculums for the Bachelor of Education (Primary) on offer. However, it is worrying that approximately 10 per cent of teacher students fail the numeracy component of the Literacy and Numeracy Test for Initial Teacher Education Students. To ensure that teachers are adequately skilled, we recommend that a 'license to teach' model be put in place. Teachers should sit the Numeracy Test every ten years to shore up their skills in mathematics teaching.

Strengthen TAFE and Vocational Education

During the consultation process, it became apparent very quickly that the NSW Government must do more to support the Vocational Education and Training (VET) sector. Businesses need both engineers and machinists. Although there is some shortage of engineering graduates from universities, good machinists are almost impossible to find. Indeed, a Certificate IV in Computer Numerical Control (CNC) programming is only offered at campuses at Newcastle and Taree.

There are welcoming early signs of change and progress. As the business environment changes, so too must vocational education. Stackable micro-credentials offered at TAFE and other RTOs should be encouraged. TAFE's new model, the TAFE NSW Institute of Applied Technology (IAT), needs to have sustained and ongoing support.

Jenkins Engineering Defence Systems

This case study highlights the **unique skills issues being experienced by a defence manufacturing supplier** – in particular, the **need to focus on STEM education in Australia** and recruitment from 5-eyes countries. It also demonstrates the **specialised support needed for procurement given the sovereign nature and long gestation times of defence projects.**

Jenkins Engineering Defence Systems Pty Ltd (JEDS), is a wholly Australian-owned company that specialises in the design, manufacture and marketing of Electronic Warfare (EW) products, including software and the service and support of EW, radar and radio communications systems.

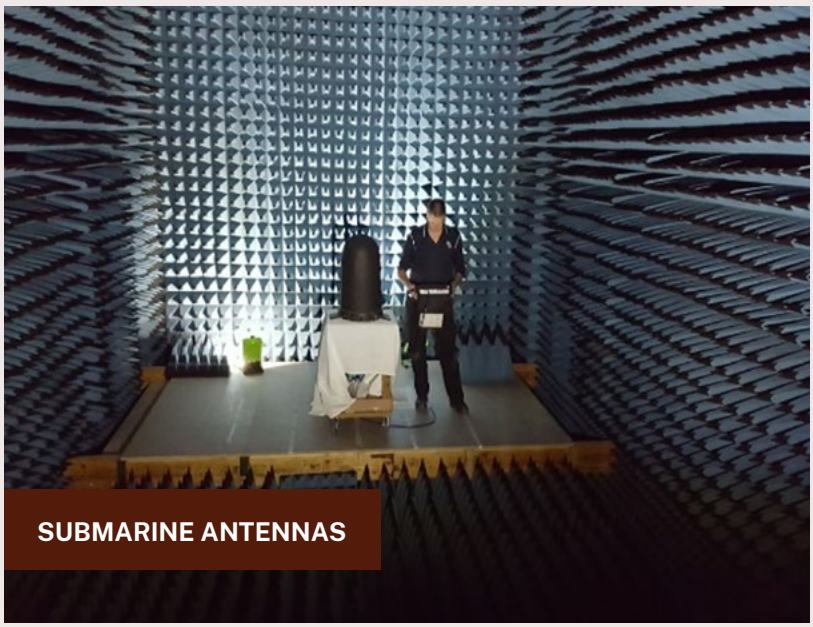
in trying to grow RF qualified and experienced engineers and technicians – as well as trying to source experienced software and systems engineers. JEDS would like to **see more government support for STEM education and training** – particularly in areas relevant to Defence e.g., RF.

Due to National Security and US International Traffic in Arms Regulations restrictions, JEDS is largely restricted to recruiting only Australian citizens. JEDS would like to see STEM programs aimed at Australian nationals, with the workforce shortages in Health and Ageing being the target of immigration programs from non-5 eyes countries, reducing the need for Defence companies to compete with other sectors of Australia's economy that are not reliant on Australian citizens.

JEDS would also like to see Federal and state government sponsored programs to upskill employees in relevant areas, e.g. 3D printing, to ensure JEDS can keep its workforce up to date on the latest commercial technologies and processes, thereby maintaining competitiveness – especially vs Australian Defence-related work being offshored to overseas-based Original Equipment Manufacturers (OEMs).

Procurement: With the long gestation period of most Defence projects, government funding support for design work is essential to maintain cash-flow within the business. A recent example was the Federal Government's intention to fund design work for the Attack-class (diesel-powered) submarine's EW system; however, this program was cancelled before JEDS' multiple-year pursuit of this work transitioned to contract – leaving the company considerably out-of-pocket.

See Appendix 3 for the full case study.



SUBMARINE ANTENNAS

UNIVERSITY OF WOLLONGONG AUSTRALIA

From its earliest beginnings, the University of Wollongong (UOW) was **formed in partnership with industry.** A **cadetship program established at BHP and then BlueScope** has spanned 43 years and continues to develop an outstanding group of leaders.

The strength of this relationship has continued despite changing economic conditions over the years. The combination of industry employment and university education provides fertile ground for fostering leaders across many industries. This relationship is leveraged to promote both the university and the high-tech nature of modern manufacturing. There have been well over 600 UOW alumni who have completed the cadetship.

BlueScope Cadetship Program

BlueScope Steel's Port Kembla Steelworks offers a number of cadetship positions every year for UOW students studying Materials Engineering, Mechanical Engineering or Electrical Engineering. This program is very competitive and targets high performing students in their first, second or third years of study (although promising HSC students are also considered). The annual intake of cadets is between usually 10 and 15 students per year, and BlueScope currently has approximately 50 students in its cadetship program.

As cadets, undergraduate students are required to work 30 hours per week for BlueScope and are provided with one day each week to attend classes and focus on their studies. Since it is not always possible to schedule all classes on one day, this arrangement is flexible, and students are given the opportunity to attend classes and tutorials during the day as long as they work the required number of hours per week. Each cadet is assigned a cadet coordinator within BlueScope to oversee their academic progress and provide them with career guidance.

This arrangement is highly symbiotic, and benefits BlueScope, UOW and the cadets. BlueScope not only gets access to top students early on in their studies, but also to young graduates who are experienced, well trained and knowledgeable about BlueScope's operations. Students are afforded the opportunity to gain invaluable experience while studying part-time and earning a salary.

In addition to promoting the cadetship program to potential students, UOW actively attempts to accommodate BlueScope cadets as much as possible. As part of their degree program, all engineering students have to obtain at least 12 weeks of approved professional experience in a relevant industry.

In addition to the cadetship program, BlueScope also makes a number of summer internship placements available every year. These placements are crucial for students who are not on the cadetship program, helping them to gain the pre-requisite hours towards their professional experience.

See Appendix 3 for the full case study.

7 Acknowledgements

Consultation process and Taskforce members' disclosures

This report is based on findings from a staged research and consultation process that considered a wide range of stakeholders including relevant businesses, industry associations and representatives, academics, workforce representatives and government agencies at all levels.

The consultations were identified through department and Taskforce members' networks, to get an even spread of representation from across the manufacturing ecosystem. Each consultation was conducted by Taskforce member(s), who brought their specialist experience, skills, and contemporary understanding of the NSW business environment to the meetings, ensuring an in-depth and probing consultation.

Special thanks go to the Modern Manufacturing Taskforce members, who generously gave their time to engage in the consultation meetings and roundtables. In the interests of full disclosure and transparency, current business and other affiliations of each member is provided below:

- Anthony Shepherd AO, Chairman of Venues NSW, the AFL GWS Giants, BINGO Industries Pty Ltd and the Inaugural Chairman of Infrastructure SA. He is also a Director of Racing NSW, Enviropacific Pty Ltd, Virgin Australia International Holdings Limited, and Snowy Hydro Limited and a Patron of Infrastructure Partnerships Australia.
- Dr Bronwyn Evans AM is the Chair of Building4.0 CRC, a Director of Standard Communications (GME), a Director of listed medical device company EBR Systems Inc (ASX EBR), and an Advisor to NewMedTek (Sydney based medical device start up). Bronwyn also Chairs the NSW Bushfire Mission Expert Panel and is an Honorary Fellow of the University of Wollongong and Engineers Australia, and a Fellow of the Australian Academy of Technological Sciences and Engineering.
- Emeritus Professor Roy Green, University of Technology Sydney, is Chair of the Advanced Robotics for Manufacturing Hub and the Port of Newcastle, and he is a Director of the Innovative Manufacturing CRC. Roy is also a Member of SA Chief Scientist advisory group, Member Industry Advisory Committee ATN universities, Member VC's Industry Advisory Board University of Newcastle, and Member of the Royal Society of NSW.
- Chris Jenkins, CEO Thales Australia and Insignia of Knight in the French National Order of the Legion of Honour. Chris is also the National President of the Australian Industry Group, member of the AIG Defence Council, Non-Executive Board Director of Naval Group Australia, Honorary Fellow of the AIPM, a Fellow of Engineers Australia, a Patron of RUSI NSW, and an Adjunct Professor of the University of NSW.
- Dig Howitt, CEO and President of Cochlear Limited is also a member of the Champions of Change Coalition STEM Group.

Consultations held

The Modern Manufacturing Taskforce members and Investment NSW would like to expressly thank all those who gave freely of their time and advice to attend consultation meetings with the Taskforce. Without your support and frank advice this report would not have been possible. Our thanks and appreciation go to the following consultees:

List of consultees (in alphabetical order)

Name	Position	Organisation
Kristina Agerback	Executive Director, Policy	NSW Procurement
Trent Bagnall	Chair CEO Founder Previously Founder and MD Professor of Practice Chair	Camplify (ASX:CHL) The Melt Slingshot QMASTOR (ASX:QML) University of Newcastle Dantia
Georgina Beattie	Deputy Secretary, Mining, Exploration and Geoscience	NSW Department of Planning and Environment
Professor John Broadbent	Founder	Realise Potential
Travis Chambers	National Manager, Trades, Engineering and Automation	Momentum Consulting Group
David Chuter	CEO and Managing Director	Innovative Manufacturing CRC (IMCRC)
Emma Cooper	Director, Policy	NSW Procurement
Professor Patricia Davidson	Vice-Chancellor and President	University of Wollongong
Dr. ir. Filip De Coninck	Chief Valorization Officer (CVO)	Flanders Make vzw

Name	Position	Organisation
Professor Jochen Deuse	Head, Institute of Production Systems (IPS), Faculty of Mechanical Engineering Adviser Director, Centre for Advanced Manufacturing (CAM), School of Mechanical and Mechatronic Engineering, Faculty of Engineering, and Information Technology	TU Dortmund University, Leonhard-Euler-Strasse 5 44227 Dortmund, Germany Flanders Make, Belgium https://www.flandersmake.be/en University of Technology Sydney
Professor Hugh Durrant-Whyte	NSW Chief Scientist and Engineer	Investment NSW
Dr Mike Fay	Director & Chief Medical Officer	Advancell
Grant Fenn	Managing Director and CEO	Downer Group
Professor Bronwyn Fox	Chief Scientist	CSIRO
Dr Jill Freyne	Deputy Chief Scientist	CSIRO
Jens Goennemann	Managing Director	Advanced Manufacturing Growth Centre (AMGC)
Rod Henderson	Managing Director & CEO	AMPControl
Dr Jonathan Iredell	Director, Centre for Infectious Disease and Microbiology	Westmead Medical Research Institute
David Jenkins	Manager Government Relations, Corporate Affairs	BlueScope
Gareth Jennings	General Manager Corporate Affairs	Rheem Australia
Stephen Kakavas	Executive General Manager – Rail & Transit Systems	Downer Group
Ben Kitcher	Executive Director Research, Skills and Technology	Western Parkland City Authority

Name	Position	Organisation
Mark Lenzner	Executive Director, ICT / Digital Sourcing	NSW Department of Customer Service
Narelle Luchetti	Head of Manufacturing Division	Commonwealth Department of Industry, Innovation and Science (DISR)
Geoff Mason (attended in place of Anthony Murfett)	Head of Division, Technology and National Security	Commonwealth Department of Industry, Innovation and Science (DISR)
Benjamin Matthewson	Project Manager	Silicon Quantum Computing Pty Ltd (SQC)
Anthea McClintock	Director Centre for Economic and Regional Development	Investment NSW
Louise McGrath	Head of Industry Development and Policy	The Australian Industry Group
Stephen Millar	Managing Director and CEO	Standard Communications (GME)
Anna Murray	NSW President	Australian Industry Defence Network (AIDN)
Emma Peacock	Head of Net Zero Economy	Investment NSW
Nick Purtell	General Manager, Manufacturing Priorities and Supply Chains Branch, Manufacturing Division	Commonwealth Department of Industry, Innovation and Science (DISR)
Zane Rebronja	Director, Skilled Migration	Investment NSW
Matthew Robertson	Manager International Markets	BlueScope
Professor Stephen Rose	Head of Clinical Development	AdvanCell
Professor Veena Sahajwalla	Director Hub Leader Director	ARC Microrecycling Research Hub Sustainable Communities and Waste Hub, National Environmental Science Program Centre for Sustainable Materials Research & Technology

Name	Position	Organisation
Brett Sandercock	CFO	ResMed
Caroline Seagrove	Relationship Manager, NSW State Government, Business Development and Global	CSIRO
Michael Sharp	National Director – Industry	Advanced Manufacturing Growth Centre (AMGC)
Damian Shrubsole	Company Secretary and Head of Investor Relations	Rapid Response Revival
Professor Michelle Simmons AO	Founder and CEO	Silicon Quantum Computing Pty Ltd (SQC)
Ian Smith	Executive Director, Office of Regional Economic Development	Department of Regional NSW
Warwick Sommer	Executive General Manager - Innovation & Service	AMPControl
Dr Cori Stewart	CEO, Head of Advanced Robotics	Manufacturing (ARM) Hub, Qld
Alan Tilley	CFO	Rapid Response Revival
Dr.ir. Dirk Torfs	CEO	Flanders Make vzw
Marina Troyak	Director ICT Supplier, Policy and Innovation Development	NSW Department of Customer Service
Rhodri Tudor-Jones	Executive Director, Investment Origination & Partnerships	Investment NSW
Professor Peter Turner	CEO	Sydney Quantum Academy
Giovanni Valentini	Director, Net Zero Economy	Investment NSW
Peter Verwer AO	Head of Division, Technology and National Security	Department of Home Affairs, Government of Australia

Name	Position	Organisation
Stephan Wagner	Regional Manager, Western Sydney	AusIndustry
Ivan Waterfield	CEO	HunterNet Co-op
Jennifer Westacott AO	CEO	Business Council of Australia (BCA)
Jonathan Wilczek	Event Manager	IEC - International Exhibition and Conference Group - Modern Manufacturing Expo
Sally-Ann Williams	CEO	Cicada Innovations
Professor Graham Wren	Senior Executive and Special Adviser to the Principal	University of Strathclyde, Glasgow, UK
Gary Zamel	Founder	New MedTek Devices

Roundtables held and list of participants (in alphabetical order)

Roundtable	Participant's Name	Participant's Position	Participant's Organisation
Albury Local Manufacturers Roundtable	Justin Clancy MP	Member for Albury	NSW Government
	Ross Dixon	Senior Manager	RSM Australia
	Tim Farrah	Director Business Services	Australian Industry Group
	Karen Habermann	Operations Manager	Albury Precision Engineering
	Linton Habermann	CEO	Albury Precision Engineering
	Anthony McFarlane	Regional Manager	Business NSW
	Ashish Swarup	National Capital Projects & Product Development Manager	Geofabrics

Roundtable	Participant's Name	Participant's Position	Participant's Organisation
Australian Industry Group Advisory Board Roundtable	Dr Alex Birrell	CEO	CleanSpace Technology Pty Ltd
	Aga Blana	Managing Director	Nautitech
	Rod Bonnette	General Manager NSW/ACT	Sims Metal Management
	Glenn Bucknell	Operations director	Zip Heaters (Aust) Pty Ltd
	Mark Burgess	CEO and Managing Director	Quickstep Technologies Pty Ltd
	John Coyle	Director	G H Varley Pty Ltd
	John Doumani	President - Zip International	Zip Heaters (Aust) Pty Ltd
	Christopher Janssen	Managing Director	GPC Electronics Pty Ltd
	Susan Just	Joint Managing Director	Playsafe Fencing Pty Ltd
	Nigel Long	CEO	Alchin Long Group
	Samuel Maresh	Country Leader	GE Australia
	Louise McGrath	Head of Industry Development and Policy	Australian Industry Group
	Neil Wilson	Managing Director	Romar Engineering Pty Ltd

8 Appendix 1: Jurisdictional review

State and international jurisdictional analysis

A comprehensive list of state and international initiatives is tabulated at the end of this section. The signature or key manufacturing development policies are described below.

The analysis below begins with Victoria, Queensland and South Australia. Analysis of examples from Germany, Singapore, Israel, Canada, Belgium and the UK follows.

State environment analysis

Victoria

Policy guidance for Victoria is contained in Advancing Victoria's Manufacturing: A Blueprint for the Future. Among other measures, Victoria claims close links between the state's universities and the manufacturing sector, equating this to an advantageous environment for manufacturing process transformation specifically and R&D generally. The claim appears to have some validity in that Victoria has managed to capture the lion's share of the Commonwealth Manufacturing Modernisation Fund, for both large and small grants.

Victoria also devotes resources to network-style programs such as LaunchVic, which provides funding to a range of programs that support start-ups, who will later feed into various advanced technology sectors. Other programs, such as industry-driven collaborative networks (for example, additive manufacturing) are heavily promoted.

The manufacturing sector is specifically targeted with funding/grants by means of the Manufacturing and Industry Development Fund and Future Industries Fund.

There is some emphasis on place-based development, such as the Regional Manufacturing Clusters Initiative. This was designed to support 'regional' manufacturing but closed in mid-2020. The Regional Jobs Fund, closing in mid-2022, offers support for various sectors including advanced manufacturing and 'new energy' technology.

Queensland

Queensland modern manufacturing initiatives have been based around an Advanced Manufacturing 10 Year Roadmap and Action Plan (The Department of State Development, Manufacturing, Infrastructure and Planning, 2018), released in 2016 and updated in 2018.

The centrepiece grant program is 'Made in Queensland'. MIQ has supported 84 advanced manufacturing projects across the state. It is expected to create more than 1,100 jobs over 5 years and more than $100m in investment. It is understood that the 2022/23 Queensland budget allocated $40 million to continue the Made in Queensland grants program. Queensland also has the regionally focused Manufacturing Hub grants program, which was allocated a further $10 million in the recent budget.

The state utilises other support strategies including a Manufacturing Ministerial Council and a Corporate Innovation Network. The Manufacturing Ministerial Council is chaired by the Minister for Regional Development, Manufacturing and Water and is responsible for strategic direction of the manufacturing industry in Queensland.

South Australia

Policy guidance for Victoria is contained in South Australia also claims significant expertise in the R&D environment, having co-sponsored capabilities such as the Australian Institute for Machine Learning (AIML). There is also a heavy emphasis on place-based collaboration via precincts such as Lot Fourteen and Tonsley Innovation District.

Manufacturing policy in South Australia includes a significant focus on Defence projects, these being major sources of employment and funding in that state, as well as being the origin of significant Commonwealth place-based investment in locations such as Osborne Naval Shipyard . This place-based investment tends to drive further investment decisions in the state's favour, based on the existence of the facility.

The federal government invests significantly in South Australia, allocating $155 million into South Australian manufacturing in March 2022. The latest grant was worth $22 million for Saab's Sovereign Combat System Collaboration Centre. The federal funding was in the form of a grant from the Collaboration Stream of the Modern Manufacturing Initiative, the largest grants available under the scheme (Sadler, 2022).

Defence manufacturing generally is high profile in South Australia, with Commonwealth decisions relating to naval shipbuilding and sustainment scrutinised closely and publicly. Notable episodes include a public and long running debate regarding competition with WA for submarine maintenance (known as full cycle docking) (Australian Defence Magazine, 2021). An acrimonious debate regarding the location of the construction of naval patrol vessels was finally resolved with a split production between SA and WA (Australian Government Defence, 2021).

There are some apparently unique features of the SA policy environment, including a state Industry Participation Policy. This is designed to ensure that businesses based in South Australia are given every opportunity to tender and participate in government contracts.

Also noteworthy is the South Australian Designated Area Migration Agreement (DAMA). This is a formal agreement between the Commonwealth and the South Australian Government Department for Innovation and Skills. The South Australian Government has entered into two DAMAs: the one of interest to NSW is the Adelaide Technology and Innovation Advancement Agreement. This agreement focuses on Adelaide's high-tech growth industries including defence, space, technology and advanced manufacturing industries.

International

The scanned international jurisdictions offer a combination of tax breaks, investment funds and targeted special purpose initiatives. The federal structure in Canada exhibits some similarities with NSW in that a combination of federal and state offerings needs to be investigated by interested businesses. By comparison, Singapore and Israel have a unitary approach, while the UK has some national programs but appears heavily weighted towards place-based development.

Germany

Germany claims to be the world leader in Industry 4.0, specifically to be the world's leading factory outfitter and leader in digitised networked production (Germany Trade and Invest, 2022).

The automotive industry is the largest manufacturing sector in Germany and is also reported to be the largest robotics customer. Germany is claimed to be Europe's 'Robotics & Automation Hub' on the strength of having 346 robots per 10,000 employees. According to the Staufen German Industrie 4.0 Index 2017, almost all auto sector companies already use "smart" concepts (Germany Trade and Invest, 2022).

German modern manufacturing capability appears to be based on an extensive matrix of arrangements at EU, Federal and state levels. Research clusters, either regional or sector based, are relatively common.

The "it's OWL" technology network is one of the most important Industrie 4.0 initiatives in Germany. It is sponsored by the state of North Rhine-Westphalia, the Federal Government and the EU. "it's OWL" connects

2. Owned by Australian Naval Infrastructure Pty Ltd (ANI), which is a Government Business Enterprise (GBE). ANI's joint shareholders are the Commonwealth Minister for Finance and the Minister for Defence

more than 200 companies and research institutes with the goal of finding solutions for processing data from machines, creating new services and business models, and using technology to improve working conditions. A crucial focus is technology transfer for SMEs (Intelligent Technical Systems OstWestfalenLippe, 2018). Overall, with the support of state, federal and EU governments, projects worth €200 million are to be launched until 2023. As a first step, five lead projects totalling €15 million will be implemented, starting in December 2018. The key topics are machine learning, big data, digital twin, digital platforms and the working world of the future (Intelligent Technicval Systems OstWestfalenLippe, 2022).

The Fraunhofer model is a well-known feature of German industry (and is the model for the UK-based Catapult network, with some differences). The Fraunhofer-Gesellschaft is reportedly the world's leading applied research organization. Founded in 1949, the Fraunhofer-Gesellschaft currently operates 76 institutes and research units throughout Germany. Over 30,000 employees, predominantly scientists and engineers, work with an annual research budget of €2.9 billion. Fraunhofer generates €2.5 billion of this from contract research (The Fraunhofer-Gesellschaft, 2022).

Germany Trade & Invest (GTAI) is the economic development agency of the Federal Republic of Germany. GTAI helps international companies identify suitable investment opportunities in and offers advisory and project support services at all stages of the investment process.

Higher education institutions offer a broad spectrum of research activities, including basic research and applied research and development (R&D). Almost 115,000 of Germany's approx. 434,000 R&D researchers work at higher education institutions and university hospitals. Higher education institutions spend a total of €18.4 billion on research and development. Almost half (€8.5 billion) comes from third-party funding. Third-party funding for research projects is sought from both publicly funded sponsors and private donors. The most important provider of third-party funding (€2.8 billion) is the publicly funded Deutsche Forschungsgemeinschaft (German Research Foundation, DFG). The Federal Government (€2.3 billion) and the German states (€140 million) are also important providers of third-party funding, followed by industry with €1.5 billion (2018).

The largest share of R&D expenditure, roughly €3.9 billion, goes to the engineering sciences; they are followed by medicine and health research, which have access to approx. €1.2 billion a year (Research in Germany, 2022).

Example state – Bavaria

Bavaria, Germany's largest state by area and No. 2 by population, is one of Europe's most advanced and successful economic regions. Its gross domestic product of €610 billion in 2020 puts it ahead of 22 of the 28 EU member states. Although Bavaria is home to global players like Adidas, Allianz, BMW and Siemens, the backbone of its economy is a population of medium-sized enterprises, many of whom are acknowledged as global market-leaders. Bavaria's advanced and strong manufacturing sector and its role as Europe's leading ICT hub puts it at the forefront of cross-industry digital innovation in areas such as autonomous driving, AI, IoT, cybersecurity and AR/VR (Germany Trade and Invest, 2022).

Invest in Bavaria is the business promotion agency of the Free State of Bavaria. Several manufacturing or R&D programs are offered under the state banner, including the Bavarian Programme for Funding Technology-Oriented Start-Ups, the Bavarian state funding programme for Trade and Industry (BRF) and the Bavarian Technology Funding Programme Plus.

Singapore

Singapore claims to be investing more than S$3 billion over five years to boost Singapore's advanced manufacturing capabilities under the Research, Innovation and Enterprise 2020 plan.

Singapore encourages Foreign Direct Investment through the implementation of various initiatives (Singapore Economic Development Board, 2022). These include incentives granted by the Economic Development Board of Singapore (EDB) and maintenance of an overall investor-friendly tax regime which support businesses from start-ups, to expanding mature companies, to multinationals moving their businesses or headquarters to Singapore (Pinsent Masons, 2022). Singapore promotes over 100 government schemes to assist and support business, grouped on GoBusiness Singapore.

Singapore places significant emphasis on being a manufacturing hub, claiming to be the 4th largest

global exporter of high-tech goods (Singapore Economic Development Board, 2022). Singapore attributes this to a high take-up rate of Industry 4.0 as the basis of a sophisticated manufacturing ecosystem. According to the 2022 NSW Innovation and Productivity Scorecard, NSW certainly lagged Singapore (in 2019) according to the measure of venture capital as a percentage of GDP. However, the same report indicates other comparative strengths for NSW, such a higher number of top 200 universities per million population. On measures such as gross investment in R&D as a percentage of GSP, NSW and Singapore are remarkably close.

Israel

The equivalent plan in Israel is the National Strategic Plan for Advanced Manufacturing in Industry (Israel Innovation Authority, 2018). According to Forbes (Mizroch & Central, 2019), venture-backed financing into Israel's I4 [Modern Manufacturing] industry grew 223 per cent in 4 years, from $113m in 2014 to $365m in 2018. The 2018 financing figure accounted for 5 per cent of global VC-backed financing into the I4 industry. According to Forbes, only the US and China are ahead of Israel on this measure.

However, Forbes argues that significant challenges to the uptake of Modern Manufacturing exist, such as the roughly 85 per cent of Israel's 22,000 registered factories that remain labour-intensive production facilities lacking the financial backing to make a modern transformation. In some ways, Israel has experienced the quintessential challenges of 21st century industry – referred to in the Australian context by Professor John Broadbent (Founder, Realise Potential). Some of the phenomena described by Professor Broadbent (Broadbent, 2022) are evident in more than one advanced economy: 'there are still legacy and cultural challenges slowing the adoption of these (Industry 4.0) technologies by manufacturing companies. These challenges include adapting existing human capital and machinery, (and) the cost involved in customising the technological solutions.' (Start-up Nation Central, 2018)

Canada (focus on Ontario)

Canada claims manufacturing is a cornerstone of their modern economy. Accounting for approximately $174 billion of GDP, manufacturing represents more than 10 per cent of Canada's total GDP. What is more, manufacturers export more than $354 billion each year, representing 68 per cent of all of Canada's merchandise exports.

As part of the 2021 Budget, Ontario committed $400 million over four years to create the Invest Ontario Fund, which will support Invest Ontario and encourage investments in the key sectors of advanced manufacturing, technology and life sciences: the three strategic sectors where the province has a global competitive advantage (Invest Ontario, 2022).

In addition to the range of programs offered under the banner of 'Invest Ontario', some specialist programs exist to considerably elevate the auto manufacturing sector. These are the Ontario Vehicle Innovation Network and the Driving Prosperity Plan, programs that signify an extended 'centre of excellence' type approach as well as a catalyst for a range of technologies involved in the mass production of EV.

Programs such as the Advanced Manufacturing and Innovation Competitiveness (AMIC) program follow what appears to be an international trend, in that there is a focus on improving access to capital. According to the government of Ontario, AMIC 'will support the advanced manufacturing sector in capital-intensive industries such as automotive, aerospace, life sciences, information technology, steel and chemicals by ensuring they have the necessary funds to invest in new technology and innovative equipment.' (Bozzato, 2022)

UK (focus on Sheffield)

Despite the decline since the 1970s, when manufacturing contributed 25 per cent of UK GDP, the UK is currently the ninth largest manufacturing nation in the world. Overall, the UK's industrial sector has increased by 1.4 per cent a year since 1948, according to a recent report from the Office for National Statistics (ONS).

One of Yorkshire's 'big four' cities in the north of England, Sheffield's historical industrial strength was based upon the manufacturing of steel and steel products. The city is now held to be at the forefront of the UK's advanced (or 'modern') manufacturing industry (Gardham, 2022).

Development initiatives in Sheffield appear to illustrate the confluence of national policy and local development programs: 'To date, UK industrial policies have involved a shifting mixture of different types of 'horizontal' and innovation mission initiatives' (House of Commons, 2018). The central goal is to develop research-based collaborations between public and private sectors and deliver new technologies to meet key challenges.

Past adoption challenges for the adoption of modern, or Industry 4.0 techniques, have included issues of:

- An overall low level of private sector R&D
- Excellent research institutions that operate at too small a scale to service the industrial base
- Excellent academic institutions that are insufficiently well-linked to industry
- A shortage of some technical skills and graduate retention (The University of Sheffield, 2016).

The national Catapult centres that exist now are designed to engage with advanced manufacturing (AM) industries to translate and commercialise innovations, thereby seeding new firms and industries (UK Research & Innovation (UKRI), 2020). University research facilities, in close conjunction with their industry partners, have been given a leading role in meeting innovation missions and creating new clusters' (Sunley, et al., 2021).

The High Value Manufacturing (HVM) Catapult program is based on best practice established by the German Fraunhofer approach (High Value Manufacturing Catapult, 2020). It is funded by a combination of core public funding from the Innovate UK grant, Collaborative R&D projects funded jointly by the public and private sectors, and commercially funded R&D contracts. Like Flanders Make, described below, HVM Catapult has physical sites that can offer shared R&D services, and offers collaboration/sharing possibilities that otherwise would be out of reach of many clients.

The UK Catapult network currently consists of nine Catapults, with centres spanning over 40 locations. Other countries with more established Technology and Innovation Centres have more. For example, the German Fraunhofer system operates 74 institutions across many sectors (Department for Business, Energy & Industrial Strategy, UK, 2021).

Innovate UK's existing criteria for identifying candidate areas for new Catapults are as follows:

- The technology/sector should have a large projected future global market.
- UK industrial capacity should be large enough to anchor significant and high-value parts of the value chain.
- The UK should have strong research capabilities in the area.
- There should be potential for government policy and actions to impact the market.
- There should be the potential for spillover benefits to other parts of the UK.
- There should be economy including from multiple sector effects, regional and technology spillovers, and impact of productivity.
- The Catapult should address a market failure that is not addressed by any existing centres or facilities.
- The Catapult should have a positive impact on both the sustainability of the UK economy and quality of life for UK citizens. (Department for Business, Energy & Industrial Strategy, UK, 2021).

Commercialisation of research is a core role of the Catapults, which requires them to facilitate collaboration between universities and businesses. Increasingly, as the UK seeks to address complex societal and global challenges such as net zero, the Catapults can also benefit from collaborating with each other (Department for Business, Energy & Industrial Strategy, UK, 2021).

Catapults' relationships with universities vary across the network. Some have deep ties with specific universities, such as the Compound Semiconductor Applications Catapult with Cardiff University. This is closest to the Fraunhofer model, where every institute is attached to at least one university. Other Catapults engage with universities ad hoc. Although Catapults should take an approach appropriate to their specific sector or technology, we note that businesses and academics have repeatedly told us that Catapults can create the greatest leverage of UK strengths by developing strong links with universities (Department for Business, Energy & Industrial Strategy, UK, 2021).

Catapults stimulate private investment by acting as centres of expertise which attract innovative companies to develop their products and services. Companies either pay to work with Catapults or work on joint projects with public funding. Typically, smaller companies are more dependent on winning public funding and larger companies can also afford to work directly with Catapults.

Catapults provide tailored support to SMEs and start-ups, with advice and toolkits that include support for products, processes, workforce development, investment and routes to export. Catapult staff proactively engage with businesses and advise them on how to overcome barriers.

Large companies and SMEs have both noted the value of skilled Catapult staff and facilities and highlighted the importance of Catapult guidance on public and private funding options. Reportedly, several projects would not have been possible without Catapult facilities and equipment. For example, the High Value Manufacturing Catapult's 'FutureForge' facility is helping companies of all sizes explore less energy intensive forging methods, and the Offshore Renewable Energy Catapult's test facility at Blyth provides research, test, innovation and validation services to accelerate the deployment of offshore renewable energy technologies. Businesses have also highlighted that the Catapults' networking and business advice have encouraged new partnerships.

Some UK researchers suggest that the notion of an automatic benefit to both industry and academic research is not always supported by fact. 'The co-location between AM and research and development (R&D) appears to have been fairly weak… In general, it reveals only a very weak positive relationship between research intensity and AM growth, which suggests that any cumulative relationship between the two has been patchy at best.' Further, 'Many parts of AM have not been located in high R&D expenditure regions, which suggests that production location decisions by AM firms, and especially foreign investors, have been influenced by other factors, such as distance and access to markets and labour (Wren & Jones, 2012). Large foreign investors have a strong reliance on internal resources, are now deeply connected into global innovation networks with other lead firms, so that regional and local knowledge spill overs are much less important to these firms (Parrilli & Radicic, 2021)." (Sunley, et al., 2021)

Belgium (Flanders region)

Flanders Make (FM) is a strategic research centre for the manufacturing industry and classic 'network of networks', including linkages to international partners. Flanders Make is designed to respond to digital or Industry 4.0 challenges. It is intended for both SMEs and large companies, focusing on research in mechatronics, methods for developing products and technology to make them. The results are applicable to a wide range of companies that face similar technological challenges.

Established in 2014, FM is focused on types of products and on production methods. There is some emphasis on vehicles including drones, hence the inclusion of 'dronecluster' EUKA along with 3 co-creation centres and 12 core labs at the 5 Flemish universities. Flanders Make is an initiative supported by the Flemish Government, the Limburg Fund and the European Regional Development Fund (ERDF).

FM is anchored on actual facilities that provide a range of highly technical shared services that smaller companies would not be able to afford. Complementing this is a broad range of partnering arrangements designed to broaden involvement in projects and stimulate co-investment. 2020 figures indicate government investment equivalent to around A$20m and matching investment from other sources of around A$9.5m.

Summary of key initiatives – NSW, Victoria, Queensland, South Australia & Commonwealth

Table of Key initiatives – NSW, Victoria, Queensland, South Australia, Commonwealth

State	Initiative	Purpose	Value
New South Wales	R&D Fund	Aims to stimulate the development and commercialisation of innovative products that address the health, social and/or economic impacts of COVID-19.	$6m
	The Tech Central Scaleup Accommodation Rebate	Program will support technology businesses in the scale-up phase of growth to establish offices in Tech Central.	The Program will provide a 40 percent rebate on eligible rental costs and a 30 percent rebate on eligible fit-out costs.
	Westmead Innovation Eco-system Fund	Fund will help to commercialise research in fields such as biotechnology, diagnostics and digital health.	$10m
	Regional Job Creation Fund (closed)	Supports existing businesses in regional NSW to grow and encourages interstate or overseas businesses to invest in regional NSW.	$140m (closed)
	Jobs Plus (closed)	Designed to support companies who want to expand their footprint in NSW. The program will reduce the cost of establishment, financial risk and increase speed to market.	$250m (closed)
	Digital Restart Fund	Supports digital, information and communication technology initiatives.	
	Technology vouchers	The (currently COVID-19 related) vouchers can be used to subsidise access to publicly funded research organisations including 11 New South Wales universities, CSIRO, National Measurement Institute, ANSTO, Defence Science and Technology Group.	
	R&D Fund	Supports small and medium enterprises (SMEs) and scale-ups to commercialise products that address the health, social or economic impacts of the COVID-19 pandemic.	
	Small Business Innovation & Research (SBIR) program	Provides competitive grants to small and medium-sized enterprises (SMEs) to find and commercialise innovative solutions to well-defined problems for NSW Government agencies.	$24m
	Bushfire Response R&D Mission	The Government has put aside funding for research and development into emerging industries and technology to better prepare the state for bushfires.	$28m

State	Initiative	Purpose	Value
Victoria	Manufacturing and Industry Development Fund	Builds sovereign manufacturing capability by providing **grant support to businesses in key growth sectors.**	**Not yet launched** (first tranche closed in 2021).
	Future Industries Fund	**Funds various projects in six identified priority sectors.**	$200m
	LaunchVic	Provides an environment for entrepreneurs to grow **early-stage innovative businesses.**	$60m
	Regional Jobs fund	Provides financial assistance primarily to businesses seeking to develop and expand operations in regional Victoria.	Unknown
Queensland	Corporate Innovation Network	Improves the opportunity for **local innovative companies to connect with large corporations**.	Uncertain
	Made in Queensland	Helps **SMEs** increase international competitiveness, productivity and innovation via the **adoption of new technologies, and generate high-skilled jobs.**	2022/23 Queensland budget has allocated $40 million to continue the program.
	Manufacturing Hubs Grant Program	Assists eligible businesses in the Cairns, Central Queensland, Gold Coast, Mackay and Townsville regions. Intended to create jobs of the future through: • Technology adoption • Skills and training • Business development • Advanced robotics	2022/23 Queensland budget has allocated $10 million to continue the program.

State	Initiative	Purpose	Value
	Research and innovation fund (RIF) – of note, the Innovation Ecosystem	**Supports researchers, entrepreneurs and businesses to accelerate** their progress.	Grants of between $20,000 and $500,000 -a maximum project duration of three years).
South Australia	Jobs and Economic Growth Fund	Funds growth of existing and new industries by building international connections, **attracting foreign and national direct investment.**	$200 million over four years from 2021.
	SA Venture Capital Fund (SAVCF)	**Enables innovative SA ventures to secure funding** and accelerate growth into national and global markets.	$50m

State	Initiative	Purpose	Value
	Venture Capital Limited Partnerships (VCLP) scheme	Offers tax benefits to fund managers and eligible foreign investors to help stimulate venture capital investment. Benefits include an exemption for eligible foreign investors from capital gains tax on their share of a fund's returns from eligible venture capital investments.	
	Early-Stage Venture Capital Limited Partnerships (ESVCLP) scheme	Provides fund managers and investors with support to help stimulate early-stage venture capital investments. Benefits include tax exemptions on an investor's share of a fund's income and tax gains.	
Commonwealth	R&D Tax Incentive (R&DTI)	Offers a tax offset for companies conducting eligible R&D activities. It encourages investment in R&D to help the company grow and innovate which generates benefits for the Australian economy.	For R&D entities with aggregated turnover of less than $20 million, the refundable R&D tax offset is the corporate tax rate plus an 18.5 per cent premium. For R&D entities with aggregated turnover of $20 million or more, the non-refundable R&D tax offset is the corporate tax rate plus an incremental premium.

State	Initiative	Purpose	Value
	Manufacturing Modernisation Fund Round 2	Round 2 is closed to applications. When open, it supports manufacturers by co-funding capital investments and associated reskilling to: • Adopt new technologies • Encourage innovation • Become more productive and competitive	
	Entrepreneurs' Programme - Accelerating Commercialisation	Includes: • Commercialisation Guidance – guidance and assistance to develop the commercialisation potential of your novel product, process or service • Accelerating Commercialisation Grants – financial assistance to help commercialise your novel product, process and service	
	CSIRO Kick-Start	Provides matched funding for start-ups and small to medium enterprises to help access CSIRO's research expertise and capabilities to help grow business.	Matched funding between $10,000 and $50,000 for start-ups and small to medium enterprises.
Commonwealth	Future Fuels Program	Provides funding to enable the demonstration and deployment of new zero emissions vehicle technologies.	Minimum funding of $500,000 – for Eligible Australian ZEV projects.
	Commonwealth Procurement Rules (CPR)	The 1 July 2022 CPRs, which replace the 14 December 2020 CPRs, include additional changes reflecting the Australian Government's commitment to sourcing from small and medium enterprises (SMEs) and ensuring more opportunities are available to SMEs to participate in Commonwealth procurement. The new CPRs will apply to any new procurements undertaken from 1 July 2022.	
	Sovereign Industrial Capability Priority Grant	Funding for Australian businesses to build industrial capabilities that fit with Defence's Sovereign Industrial Capability Priorities.	A grant of $50,000 to $1 million for up to 50 per cent of the cost of a project that builds capabilities aligned with Defence's Sovereign Industrial Capability Priorities. The maximum grant period is 30 months. Grant funding is capped at $3 million in a 3-year period per recipient. The business must be a company incorporated in Australia.

State	Initiative	Purpose	Value
Commonwealth	Joint Strike Fighter Industry Support Program –Production and Modernisation Grants	Provides Australian companies and institutions with funding to develop new or improved capabilities to win work in the production and modernisation phases of the Joint Strike Fighter Program. For an Australian company, university, research organisation or cooperative research centre.	Grants from $150,000 to $1.5 million to fund up to 50 per cent of eligible project expenditure.
	Defence Global Competitiveness Grant	Grants to help Australian businesses (SME) invest in projects that build their defence export capability.	A grant of $15,000 to $150,000 for up to 50 per cent of the cost of investing in projects that build export capability to build a stronger, more sustainable and globally competitive Australian defence industry. The maximum project period is 12 months.
	Australia-US International Multidisciplinary University Research Initiative (AUSMURI)	Australian universities participating in approved submissions on a designated topic under the US Multidisciplinary University Research Initiative (MURI) can apply for a grant. AUSMURI supports the development of fundamental and basic research to strengthen Australian university research capacity, skills, and global networks in fields of priority for future Defence capabilities.	A grant of up to AUD$1 million per year for 3 years to fully fund a research project on a designated topic.

Summary of key initiatives – Germany, UK, Singapore, Canada, Israel, Belgium

Table of Key initiatives – Germany, UK, Singapore, Canada, Israel, Belgium

State	Initiative	Purpose and Beneficiaries	Value
Germany	Joint Task for Improving Regional Economic Structures	Based on EU regulations and confirmation by the European Commission, it defines maximum possible incentive rates for facility set-up cost - for all regions eligible for funding - throughout Germany.	The actual incentive amount granted varies from region to region subject to economic indicators. Regions with the highest incentive rates offer grants of up to 45 percent of eligible expenditures for small enterprises and grants of up to 25 percent for large enterprises in the eastern part of Germany.
	R&D grants, interest-reduced loans, and special partnership programs. Financing is provided by the German government, and the individual German states.	R&D incentives programs generally provide money for R&D project personnel expenditure. Other costs for instruments and equipment may also be eligible.	The total amount of incentives a project may receive depends on the size of the company (small, medium-sized, or large), whether the project is conducted in cooperation with other companies or research institutes, and the research category of the project.
	German states offer a range of labour-related incentive programs designed to fit the different company needs.	The range of programs offered can be classified into four main groups: • Recruitment support • Training support • Wage subsidies • And on-the-job training	Incentives are available throughout Germany, independent of factors such as company size, industry sector, or investment project location. Programs can be carried out and adjusted by local authorities according to investor needs.
	Publicly subsidised loan programs	Provided by so-called development banks: publicly owned and organised banks which exist at the national and state level. Each financial tool or program offered by such banks is accessible to foreign investors and subject to the same conditions available to investors from Germany.	Each German state has its own development bank financing projects within the respective state. They offer own loan programs, especially targeted at start-ups and growing companies. State development bank loans are generally tailored to meet the requirements of small and medium-sized enterprises (according to the EU Commission's SME definition).

State	Initiative	Purpose and Beneficiaries	Value
Germany	European Investment Bank (EIB) finances investment projects in cooperation with private banks. The EIB provides loans below general market conditions, offers long-term repayment periods.	The EIB only finances projects contributing to the EU's general economic policy objectives - enhancing the development and integration of economically weaker regions and building up the general structure of the EU as a business location. The EIB acts as a financial partner until the investment project is completed. Loans are granted to projects in both the public and private sectors. EIB loan programs are open to large enterprises as well as SMEs. To receive support, projects must be viable in four areas: • Economics • Technology • Environment • Finance	As a rule, the EIB lends up to 50 percent of investment project costs.
	Public guarantees can replace or supplement any shortfall in securities.	New companies often experience difficulties securing financing through the capital markets as, frequently, the required loans can only be collateralised to an insufficient degree. In these cases – with economically appropriate projects – public guarantees can replace or supplement any shortfall in securities.	Guarantee programs are available via a federal state's guarantee banks, via the individual state government or via the individual state government together with the federal government.
Germany – Bavaria	Various	Applicants must be companies with their headquarters or a branch office in Bavaria.	Over a period of one year, a maximum of 50 per cent of eligible expenses can be covered.
	Wachstumsfonds Bayern	Supports technology companies that have successfully concluded their seed and initial start-up phases with equity capital to finance investments and operations as part of an innovation undertaking.	An investment by Wachstumsfonds is only possible if independent private investors have a participating interest in the company at the same conditions and in the same amount.
	Bavarian Programme for Funding Technology-Oriented Start-Ups	Technology-oriented companies that have existed for fewer than six years, have fewer than ten employees and meet the criteria of an SME. Funding can be used to cover expenses related to rent and staffing, market launch of a product and research and development.	Development projects at a maximum of 45 per cent. Conceptual projects at a maximum of 35 per cent; technological work during the concept phase at a maximum of EUR 26,000.

State	Initiative	Purpose and Beneficiaries	Value
Germany – Bavaria	ESA Business Incubation Centre (BIC) Bavaria	Companies with innovative products and digital core competencies whose founding is imminent or whose founding occurred within the last three years at most.	Financial support (EUR 50,000 grant and loans of up to EUR 50,000) as well as technical support, office space and consulting.
	Entrepreneur trips	In collaboration with partners in the target market such as embassies and chambers of commerce, the entrepreneur trips provide the opportunity to make contacts with potential business partners.	Overall value unknown.
	Bavarian state funding programme for trade and industry (BRF)	Investments in assets of property, plant and equipment, such as machines and buildings.	Creation and/or safeguarding of jobs - Minimum investment of €200,000 in 'areas with a particular need for action', otherwise €500,000.
	Transformation@Bayern (T@B) special programme	SMEs headquartered in Bavaria. Undertakings in the field of transformation and digitisation are eligible for this funding. Investments in new measures of digitisation as well as in new, innovative procedure, production and communication processes are eligible for funding.	The minimum investment is €200,000.
	Bavarian Research Foundation – high technology for the 21st century	Cooperative projects: collaboration of one or several companies with one or several partners from the scientific community.	The funding rate is generally up to 50 per cent of the eligible expenses for industrial research and for feasibility studies. For experimental development, the funding rate is up to 25 per cent; exceptions can be made for fundamental research of strategic importance and of an extraordinary nature with 100 per cent of eligible expenses being funded.
	Bayerisches Verbund-forschungsprogramm – various topic specific programs including: BayVFP – Mobility – Innovative drive technologies and BayVFP – Mobility – Space flight	Specialised R&D in drive technology and space.	Total unknown.

State	Initiative	Purpose and Beneficiaries	Value
Germany – Bavaria	The Deutsche Forschungsgemeinschaft (German Research Foundation, DFG)	DFG also supports knowledge transfer between research and industry. German companies are affiliated to different, usually industry-specific associations to effectively represent their collective interests. The Federation of German Industries (BDI) is the umbrella organisation for more than 40 affiliated industrial associations that represent the interests of over 100,000 companies with more than 8 million employees.	The largest investments are made by the automotive sector: carmakers and their suppliers spend almost 40 billion euros on research and development (internally and externally). That is well over one third of the total amount invested in R&D by German industry. Accordingly, this is also where the largest number of people are employed: almost 132,000 employees work in R&D for the automotive engineering sector.
Singapore	Pioneer Certificate Incentive (PC) & Development and Expansion Incentive (DEI)	Encourage companies to grow capabilities and conduct new or expanded economic activities. Corporate tax exemption or a concessionary tax rate on income derived from qualifying activities.	Overall value unknown.
	Startup SG Tech	The Startup SG Tech grant fast-tracks the development of proprietary technology solutions and catalyses the growth of start-ups based on proprietary technology and a scalable business model. Startup SG Tech is a competitive grant that supports Proof-of-Concept (POC) and Proof-of-Value (POV) for commercialisation of innovative technologies.	
	Enterprise Development Grant (EDG)	This grant supports projects that upgrade a business, innovate or venture overseas. The grant funds qualifying project costs, namely third-party consultancy fees, software and equipment, and internal staff cost.	
	Industry 4.0 Human Capital Initiative (IHCI) Enabler Programme	With up to 90 per cent funding support, the IHCI Enabler is an 8-week programme that focuses on helping companies get started on Industry 4.0 transformation.	

State	Initiative	Purpose and Beneficiaries	Value
Singapore	Business Grants Portal	Brings government grants for businesses into one place, so it's easier to find and apply for the right ones.	
	Smart Industry Readiness Index	The Smart Industry Readiness Index (SIRI) was created by the Singapore Economic Development Board (EDB) in partnership with a network of leading technology companies, consultancy firms, and industry and academic experts. Now administered by the International Centre for Industrial Transformation (INCIT).	
Israel	Pilot Programs with Prominent International Beta Sites	Israeli technology companies with products ready for trial that are interested in testing them via international collaboration with foreign entities.	Overall value unknown.
	R&D Fund Program	Supports commercial companies currently developing new products or upgrading an existing technology. The program offers the largest financial incentive awarded by the State of Israel for Israeli corporations' R&D activity and is offered to all sectors.	
	Approved / Privileged Enterprise Programs. Investment incentives are outlined in a Law for the Encouragement of Capital Investment.	Approved Enterprises in a development (priority) area may receive fixed asset grants of 10 per cent-32 per cent. In addition, approved enterprises may benefit from low company tax rates of 10 per cent-25 per cent for a period of seven to fifteen years.	
Canada (Ontario)	Invest Ontario	Encourage investments in the key sectors of advanced manufacturing, technology and life sciences.	A $400 million fund over four years. Covers expenditure on elements detailed below:

State	Initiative	Purpose and Beneficiaries	Value
Canada (Ontario)	Tax Credits	• Ontario Innovation Tax Credit (OITC) — An 8 per cent refundable tax credit on a maximum of $3 million in eligible expenditures. • Ontario Research and Development Tax Credit (ORDTC) — A tax credit for Canadian corporations based in Ontario. These corporations can earn a 3.5 per cent non-refundable credit on eligible R&D to offset corporate income taxes payable. • Scientific Research and Experimental Development Tax Incentive (SR&ED) — A tax credit for companies to lower costs for key inputs, including wages/salaries. • Co-operative Education Tax Credit — Hire business-ready undergrad, masters and PhD talent from Ontario universities and colleges with help from this 25-30 per cent refundable tax credit (to a max of $3,000 per placement).	
	Special purpose offerings	• Customized Working Capital — A loan program for tech companies that want to raise working capital for growth through financing from $250,000 to $35 million. • Women in Technology Fund (WIT) — A fund that supports Canadian women-led technology companies, of any size, at every stage of growth. • Canada-Ontario Job Grant — Receive one-sixth of eligible training costs, to a max of $10,000 per person to train new or existing employees in Ontario. • Mitacs — An internship program for Ontario R&D projects covering 50 per cent up to $15,000 and a postdoctoral fellowship program for companies looking to develop an in-house R&D team covering 50 per cent of the $60,000 stipend per fellow per year.	
	Ontario Vehicle Innovation Network	Accelerate electric driving development in the province. Programs include: • R&D Partnership Fund - Connected and Autonomous Vehicle • R&D Partnership Fund - Electric Vehicle • R&D Partnership Fund - WinterTech	$56.4 million

State	Initiative	Purpose and Beneficiaries	Value
Canada (Ontario)	Ontario Driving Prosperity plan	Programs accelerate the development of electric, connected and autonomous driving technologies. The plan includes faster write-offs of the cost of capital investments. Additionally, Ontario offers a preferential CIT rate of 10 per cent on income from manufacturing and processing. Ontario also offers a Regional Opportunities Investment Tax Credit to corporations that build, renovate or purchase commercial and industrial buildings in designated regions of Ontario.	Overall value unknown.
	Advanced Manufacturing and Innovation Competitiveness (AMIC) - second application period later in 2022	Provide financial support to advanced manufacturing companies with a focus on small and medium-sized enterprises across Ontario. It will provide investments in capital equipment, technology adoption and skills development.	Loans up to 15 per cent of funding to a maximum of $5 million, interest free during the project period (up to four years). Grants are available only for specific circumstances, up to 15 per cent to a maximum of $500,000 for small companies located in rural communities of $1.5 million for strategic projects that are foreign direct investments or from companies competing against other jurisdictions or companies with significant reshoring projects.
UK	Catapult High Value Manufacturing	Established by Innovate UK, connects business and academia, providing access to research and development facilities and expertise that would otherwise be out of reach for many businesses in the UK.	Overall value unknown – estimated at around 375 million pounds or around A$660m[3].
	Advanced Manufacturing Research Centre (AMRC)	Rotherham and Sheffield: transform industrial and economic performance by making step changes in productivity, increasing competitiveness, developing new products and processes and training new talent and skills.	Overall value unknown.
	Advanced Manufacturing Research Centre (AMRC) North West	Focus for research (and 5G Factory of the Future test bed) on advanced manufacturing sectors including aerospace, digital manufacturing, clean energy technologies and additive manufacturing.	£20m grant from the Lancashire Enterprise Partnership (LEP) Growth Deal.

State	Initiative	Purpose and Beneficiaries	Value
	Made Smarter	Funding to purchase new technology depending on needs. There are different funding streams available for digital adoption. For SME manufacturing business, based in the North West, North East, West Midlands or Yorkshire and Humber regions.	Up to 50 per cent match funding (max-imum of £20,000) is available for equipment and/or specialist advice to implement projects (Yorkshire and the Humber).
	UKRI (a non-departmental public body sponsored by the Department for Business, Energy and Industrial Strategy (BEIS).)	Funding to researchers, Businesses, universities, NHS bodies, charities, non-governmental organisations (NGOs) and other institutions. Funding is provided for every stage of research.	For example: Twelve fellows are supported with an overall investment of £10 million funded by the Engineering and Physical Sciences Research Council (EPSRC). An additional £2.5 million for three fellows from the National Quantum Computing Centre (NQCC) as part of the UK's National Quantum Technologies Programme (NQTP).
	UK Patent Box	The UK patent box regime is a statutory tax incentive regime that enables companies to claim an effective 10 per cent corporate tax rate on certain qualifying IP profits. The patent box regime is a valuable UK incentive and will become even more beneficial with the announced increase in the UK corporation tax rate to 25 per cent from 1 April 2023.	
Belgium (Flanders)	Flanders Make	• Test facilities to optimise production • Test facilities focused on product validation • Innovation Boosting: Flanders Make is commissioned by a company to investigate the feasibility of their innovative idea • DigiHub system: Each regional DigiHub has its own ecosystem of knowledge institutions • Subsidies for Development or Research projects • Valorization and Acceleration projects • Collaborative Research • Strategic Basic Research	The Flemish government expects that the covenant (Flanders Make allocated) funds are supplemented by at least the same volume of financial resources, raised from other sources. In 2020 this appears to have been around 13,5 million Euros in Covenant funding and 6,5 million Euros non-covenant[4].

3. Approximating to about $11.7 per human in England. Applying the same ratio in NSW would suggest expenditure of A$93.6m
4. Flanders Make recorded a negative operating result for the financial year 2020 – according to the 2020 Annual report. This result includes costs (€492,883) of specific research for which funds were carried over, resulting in a claimed positive result of €255,433.

9 Appendix 2: NSW Advanced Manufacturing Industry Development 2018

Progress to date

NSW Advanced Manufacturing Industry Development Strategy (2018) status as at June 2022

Goal	Deliverables	Stage	Progress update
Goal 1. **Facilitate the development of advanced knowledge to foster collaboration and research within the industry and with research institutions**	• Strengthen the capacity for industry, government and research institutions to engage and collaborate • Support NSW advanced manufacturers' access to existing NSW Government and Commonwealth Government programs and funding initiatives	Delivery	• Delivering Industry 4.0 Skills Training Program • VET Diploma of Applied Technologies – launched by DoE. Western Sydney and Hunter pilots progressing • Driving Digital Skills program including microcredentials – Six companies selected for pilot • Digital Engineering Higher Apprenticeship model – technician level training. Manufacturing companies approached to participate. • Sustainability Advantage program • New Era of Manufacturing Program - introducing industry to schools (Central Coast, Western Sydney) • Ongoing work linking industry with schools as part of the DoE RIEP program. **June 2022 Update:** • Driving Digital Skills program pilot completed. Recruitment underway for Stage 2 of the pilot. • March 2022: Establishment of Modern Manufacturing Taskforce and recruitment of Modern Manufacturing Commissioner to report to NSW Govt on its role in advancing the sector and addressing sector issues. • Letters of support drafted to help NSW manufacturers access Commonwealth Modern Manufacturing Initiative funding. • Many advanced manufacturing and related technology sub-sectors included in OCSE 20-year R&D roadmap such as robotics, AI, synthetic biology, energy efficiency and others.
Goal 2. **Drive the adoption of advanced processes to support and facilitate skills development in the NSW manufacturing industry**	• Assess and address the skills gap in the NSW advanced manufacturing industry • Promote advanced manufacturing as a career path • Promote and support the creation of traineeships, internships and apprenticeships with SMEs • Map and showcase NSW advanced manufacturing industry skills and capabilities	Delivery	• Manufacturing Efficiency Funding Program. Second round of program completed Aug 2020. Manufacturing businesses may now apply for incentives under the NSW Energy Savings Scheme. • Industry Capability Connect Workshops (Regional NSW). Delivered with AMGC. Resumption anticipated shortly. On hold whilst reassessing post COVID recovery and action plans. • Workforce development initiatives for investors, growth potential companies and their supply chains. Collaboration with Training Services DoE to provide value-add to NSW manufacturers via workforce development programs.

Goal	Deliverables	Stage	Progress update
			June 2022 Update: • 15 NSW manufacturers utilising Dept of Education Workforce Development program to address their labour issues because of Investment NSW engagement. • Feb 2022: Announcement of NSW Govt's $37 million New Education and Training Model (NETM) industry-led short courses to deliver more than 7,000 training places over 4 years in the Western Parkland City.
Goal 3. **Support the implementation of advanced business models that lead to high-value manufacturing solutions and create products that fulfil previously unmet needs**	• Accelerate NSW manufacturers' adoption of Industry 4.0 business models • Support start-ups and SMEs to be globally competitive	Delivery	• Funding of the Industry Capability Network NSW (ICN NSW) $1.4m per year to provide supply chain matching services to SMEs. Services continue to be delivered to connect NSW SMEs to large public and private sector projects, especially in construction, transport, infrastructure and defence. In Q4 2021/22 only 30 manufacturing projects (including 22 Defence projects) were serviced by ICN out of a total of 292 projects. • Transforming Manufacturing in NSW workshop - IMCRC FutureMap diagnostic tool. Being utilised to add value to participants in other NSW Government manufacturing support programs. • Advanced Manufacturing Connect Program. Monthly newsletter delivered to over 300 subscribers. • Australian Fashion Week June 2021. Future of Fashion is Intelligent industry forum – 70 participants. Discussions with stakeholders on Fashtech hub as part of Tech Central. Planning for Australian Manufacturing Week activities (ICC Sydney, June 2022). Stakeholder engagement underway. **June 2022 Update:** • Extension of NSW funding deed for a further 12-months to 31 Dec 2022. • Development and publication of Advanced Manufacturing in NSW page on Investment NSW sector opportunities webpages. • Support for Australian Manufacturing Week Activities June 2022: - Sponsor of VIP Networking event (Investment NSW) - Co-hosting of Smart Sensing Showcase with NSSN and universities (Investment NSW) - Make the Future 2022 - AMRF Manufacturing Technology Conference (WPCA) - Student tours and webinar (Investment NSW with DoE Training Services)

Goal	Deliverables	Stage	Progress update
Goal 4. **Grow exports and attract investment in the NSW advanced manufacturing industry**	• Promote NSW's advanced manufacturing capabilities internationally • Develop export capabilities in advanced manufacturing businesses • Attract foreign direct investment • Support the establishment of the Western Sydney Aerospace and Defence Industries Precinct	Delivery	• Buyer Seller Connections - Industry Capability Network and Western Sydney Business Connect (Western Sydney). Part of Going Global program. • Export Capability Workshops (Sydney and Regional NSW) • NSW-India Advanced Manufacturing Trade Mission delivered by Investment NSW with Western Sydney University's Launch Pad Technology Business Incubator) part of a broader $1.58 million NSW-India Technology Exchange Program (April 2020). • Advanced Manufacturing Research Facility (WPCA). In June 2021, the NSW Government announced funding for the First Building in the Bradfield City Centre - a multi-purpose facility that will hold a visitor centre and advanced manufacturing capabilities covering additive manufacturing, machining, composites and manufacturing digitisation and automation technology. The First Building will be a trial of the larger scale AMRF. **June 2022 Update:** • As of 9 June 2022, the Regional Job Creation Fund Round One funded 80 manufacturing projects totalling $65.44 million in funding awarded and 3,433 FTE jobs. • Uptake of $250 million Jobs Plus program by many manufacturing businesses looking to expand their footprint in NSW. Approximately 50 per cent of applications are from manufacturing businesses. • 26 NSW manufacturers participated in Investment NSW 2020/21 E-commerce Skill Webinars for Exporters. 2021/22 program underway. • 112 NSW manufacturers benefitted from the NSW Export Assistance Grant program with $1.05m distributed. • Projected export sales of $2 million over 12-24 Months from the four participants in the Investment NSW Advanced Manufacturing export stream 2020/21. • May 2022: Announcement of investment of $260 million by NSW Govt in AMRF - national-first shared-use research facility – and release of first tender package.

Advanced Manufacturing Industry Development Strategy (2018) – Driving Digital Skills Pilot Program

Driving Digital Skills is a pilot program designed to improve current industry workers' digital skills and safeguard employment in the rapidly changing business environments of advanced and growing industries across New South Wales (NSW). Developed by Investment NSW and the Department of Education - Training Services NSW, the program addresses the need to support existing workers – including those at risk of displacement due to job redesign – as innovations and emerging technologies alter the way we work.

Outcomes included:

- The Industry 4.0 training has assisted the delivery of skilled workers to priority industries including food and beverage, fabrication, medtech and defence industries:
  - Skills Lab (RTO funded under Smart and Skilled) currently has 28 learners in NSW going through the Diploma of Applied Technologies – these are a mix of digital apprentices and existing workers doing the qualification
  - There are 17 learners who have recently gone through the Driving Digital Skills Pilot (Stage One)
  - At any point in time, Skills Lab has a healthy number of NSW students going through Industry 4.0 Short Courses based on stackable micro-credentials
  - There are 8 digital high apprentices in NSW now with more commencing shortly
  - Participants in the pilot program can continue to upskill alongside project delivery or as they progress in their career, and even stack their micro-credentials to build more comprehensive accreditations.
- IMCRC helped assess the current state of the businesses involved to identify areas of focus and potential investment to transform and future-proof the businesses through their Futuremap workshop. This workshop was complemented by the SME@UTS program, breaking down the barriers of innovation investment by providing businesses with customised access to UTS's innovation expertise and solutions, research capabilities, student talent and world-class technology facilities:
  - Opportunities and challenges that came from workshop:
    - » Market – half of companies have uniqueness that creates value, 2/3 have opportunities to increase services and 13 per cent export high proportion of products
    - » Leadership in disruptive and digital world – 40 per cent have appropriate vision, strategy and goals, 15 per cent regularly communicate these to employees and 2/3 have priorities determined by operational or financial imperatives
    - » Innovation to compete – 2/3 have capacity and capability to be more innovative, 40 per cent have barriers preventing them from being more innovative and invest in technology primarily to improve productivity and lower cost
    - » Digital Industry 4.0 – 6 per cent aware of Industry 4.0, 1/3 understand how to capture or create value and 20 per cent have a well-defined digital strategy.
- SME@UTS introduced a powerful, practical and partnership-led approach to research around commercialisation of innovation through:
  - Rapido advanced technology development, ProtoSpace additive manufacturing facility, Tech Lab multidisciplinary R&D facility
  - Capital connections with tech vouchers, innovation connections, NSW R&D Funding and R&D Tax rebate
  - Talent pipeline through internships, APR PhD internships, team projects
  - Masterclasses in innovation leadership, business model innovation and supply chain optimisation.
- Qualitative outcomes included:
  - Organic commercial connections such as Forcite deciding to move into Sydney Motorsport Park Innovation Precinct (delivery partner in DDSP); SMSP talking to another company about commercial deal
  - Connections to the right people to speak to about industry standards, sustainability and talent pipeline
  - More focused direction on workforce development plans with an industry led approach
  - Jobs Plus industry development around workforce development.

Australian Manufacturing Week – Industry/ School Engagement

Support for Australian Manufacturing Week activities by Investment NSW included working collaboratively with the Regional Industry Education Program (RIEP) on the following:

- Investment NSW and Department of Education developed a webinar on opportunities in advanced manufacturing with 600 students attending from 38 schools.
- Two schools attended the Australian Manufacturing Week Expo, including 10 students from Central Coast (from Kariong Mountains HS) and 10 Sydney metro students (from Holy Cross, Ryde) accompanied by teachers and interested stakeholders. Feedback was of a very positive and interactive experience for students.
- Lincoln Electric (AR welding machines) has invited students to attend their training facility as an extension of their interaction on the stand.
- Department of Education, VET Programs for Secondary Students:
  - Implemented a pilot program with 16 schools
  - Three hubs established – Mid North Coast, Hunter and Illawarra
  - Schools involved purchased 2 Augmented Reality Welding machines each and approximately – 50 teachers from across these schools were trained in their use in a one-week training program
  - Teachers now implement the use of the machines in their delivery of Manufacturing and Engineering course which follows the MEM training package
  - Goal is to prepare students to enter the industry with some skills and knowledge.
- Sydney Region (Ultimo Campus) deliver the MEM50212 Diploma of Engineering-Technical to approximately 70 students per annum. Included are mechatronic (Industry 3.0) units in programmable logic controllers and electronic switching and timing. Additionally, their studies include a competitive systems and practices (CSP) unit in root cause analysis. Moreover, this course also includes engineering principles, encompassing mathematics, material science, digital design, statics and dynamics. This qualification also provides an articulated pathway to UTS engineering degrees incorporating hybrid VET/HE/d learning in semester 2.
- As part of a 'Mechatronics Summer Skills' program in 2020, 24 students completed a statement of attainment at Ultimo.
- In 2022, under the New Education and Training Model (NETM), TAFE NSW was successfully granted a contract to deliver micro-credentials and development for Introduction to Technical Drawing and Create Technical Drawings originated by Romar Engineering, targeting 200 students. TAFE NSW has also submitted a response for a further two NETM micro-credentials in digital manufacturing technologies (100 students) and is currently responding to a suite of robot welding micro-credentials.
- TAFE NSW has recently responded to a TSNSW request for manufacturing and engineering statements of attainment. TNIs include:
  - Mathematics
  - Automation
  - Computer Numerical Control/Computer Aided Manufacturing
  - Fluid systems
  - Welding supervision
  - Welding inspection
- 2022 Fee-free courses in Python Programming
- 2022 Statement of Attainment in Digital Literacy – Intermediate
- 2022 Statement of Attainment in Introduction to Digital Skills
- 2022 Spotlight event: Factory Automation in the Fourth Industrial Age, presented by Siemens Australia Digital Industries for TAFE NSW. Included a teacher capability of 22 staff.
- 2022 Spotlight event: Industry 4.0 and applications to welding, presented by UOW Facility for Intelligent Fabrication for TAFE NSW. Included a teacher capability of 18 staff.

There is increasing interest in technical traineeships in manufacturing and engineering. Companies including UGL and Babcock Australasia are addressing technician skills gaps through paid employment and training programs. Also, prime defence contractors have expressed interest in aerospace technician traineeships.

Testimonials

Beak & Johnston Pty Ltd

Following is an overview of the Beak & Johnston initiatives under the Workforce Development program. It is an outstanding example of the support available and provided to them.

Beak & Johnston have been working with the Training Services Workforce Development team since November 2021 and a tailored Workforce Development Plan has been negotiated to implement several key initiatives over a period to attract talent and skill staff.

Current initiatives in progress with the potential to be ongoing.

Current Staff Traineeship Program

26 Beak & Johnston new entrant staff have been identified to commence a NSW Traineeship in various vocations including Food Processing, Supply Chain Operations and Leadership and Management. Individual Traineeship nominal terms vary depending on the vocation, however the expected duration will be between 8 to 12 months. Traineeships combine work-based training with an employer and formal training from a training provider. They are established under training contracts between the employer and the trainee and are regulated by government. They are a great way to be paid for work, learn and earn a qualification.

Specialist Talent Attraction Support

The Workforce Development team engaged and funded a specialist recruiter to work with Beak & Johnston on developing a Job Profile and Talent Attraction strategy that would see 30 suitable candidates referred to Beak & Johnston for interviews. Candidates were sourced, interviewed and put through an assessment to ensure the right fit before being referred to Beak & Johnston.

Talent Attraction Promotion

The Workforce Development team developed a job profile of Beak & Johnston vacancies and then promoted the 180 jobs to a number of key stakeholders including Registered Training Organisations

to attract VET Alumni, Higher Education Connections, DESE Connections to access unemployed candidates, Refugee Employment Support Program and a range of other service providers that engage talent pools. Candidates were directed through to Beak & Johnston to undertake their application and interview process

Manufacturing School Industry Showcase

Beak & Johnston participated in the Regional Industry Education Partnerships Manufacturing School Industry Showcase Webinar on 4 April 2022. The webinar was promoted across the state to all schools. Approximately 200-300 participants joined live, and the event was recorded. The event raised awareness of the future careers that will be available and the learning pathways that will enable students to secure those jobs. It showcased industry facilities and working conditions and workplaces, and built connections for students as an opportunity to consider. These programs empower students so they can make informed choices on future career paths and also equip parents and careers advisors to provide informed guidance on those chosen career paths.

The next stage of the School Industry Showcase is to run site tours and work experience opportunities for interested students later in the year. Beak & Johnston intend to participate in a range of events with the Regional Industry Education Partnerships (RIEP) team including career expos, talks with school students and other in school events.

RIEP connects local industry and secondary school communities.

The partnerships provide opportunities for:

- Sharing values and expectations for building our future workforce
- Helping employers engage with schools
- Supporting students to plan their future career pathways
- Improving students' career prospects

Driving Digital Skills Pilot Program

Driving Digital Skills is a pilot program designed to improve current industry workers' digital skills and safeguard employment in the rapidly changing business environments of advanced and growth industries across New South Wales (NSW).

Developed by Investment NSW and the Department of Education, Training Services NSW, the program addresses the need to support existing workers', including those at risk of displacement due to job redesign, as innovations and emerging technologies alter the way we work.

Two Beak & Johnston colleagues participated in the 12-week program delivered collaboratively through Skills Lab, HR Culture, and the Innovative Manufacturing Cooperative Research Centre (IMCRC) that benefits both workers and the business by offering the following digital technology and mentoring training:

- Industry-led micro-credentials course/s – Skills Lab
- Interactive and experiential workshops – HR Culture
- Futuremap workshop – IMCRC

Planned future initiatives include

Upskilling of Existing Workers

The next phase of the plan is to work on several existing worker training programs to upskill Beak & Johnston staff. Currently there is an interest to implement programs targeting skills in Leadership and Management, Training & Assessment and previous conversations indicated several non-accredited, part and full qualification training programs for Beak & Johnston's existing workforce. These programs will be tailored to Beak & Johnston's identified needs.

Beak & Johnston have recently enrolled 30 existing staff into the Certificate IV Leadership and Management and Certificate III in Supply Chain Operations.

15 March 2022.

Smiths Cooking Systems P/L

Below is a testimonial from John Smith, CEO of Smith's BBQs located in Temora NSW. The testimonial is regarding services provided by the **Industry Capability Network NSW** (ICN). ICN has been funded by the NSW Government **(Investment NSW)** for about 30 years.

I want to thank you very much for all of the recommendations and introductions you have made over the past 6 months. The connections I have made through your introductions have been invaluable for my business.

And in particular with the University of Wollongong. I went on one of their 2 day UOW Intelligent Fabrication tours at their Wollongong faculty. It was amazing what they are doing there.

I was able to meet numerous UOW staff and since, they have offered a lot with assistance in the robotic space.

I was able to attend a full day training day with a Year 10 Temora High School student this last Monday to their Nowra facility. This student has come highly recommended from some of his High School teachers. The day was learning about basic programming of Cobots (Collaborative Robots). Staff at UOW could see his potential and suggest he completes his schooling and consider a Mechatronics / Engineering Degree. Meanwhile, he will be able to do some after school work within my business to program and operate the Cobots I will be investing in soon.

Geoff, through your introduction to the UOW, I am sure you've helped that young man to follow a career path he would not have imagined possible while living in Temora regional NSW.

There are opportunities for my company Smiths Cooking Systems P/L and UOW to work on projects in collaboration. They have also been able to help in providing information with some of the various government manufacturing grants.

I appreciate all of the other introductions also. I am working with several of these companies which has led to new business relationships.

Thanks again! Best Regards, John

Smiths Cooking Systems P/L

24 March 2022

10 Appendix 3: Case studies

Ampcontrol

Themes

- Actively seeking external collaborators to maximise potential for research and development success.
- Responding to industry needs and challenges through innovation.

Company

Founded in Newcastle NSW in 1968, Ampcontrol is Australia's largest privately-owned electrical engineering company. It leads advanced global manufacturing of award-winning innovations, products, solutions and service to the resources, infrastructure, and energy sectors.

Location

Ampcontrol operates across several sites in NSW, with its corporate office based in Tomago. There are also Ampcontrol sites in QLD, Victoria, South Australia and Western Australia, as well as in Southeast Asia.

Size

Ampcontrol employs over 850 employees across 30 operations worldwide.

Operation

Ampcontrol has over 50 years' experience delivering integrated electrical, electronic and control solutions to the energy, resources, infrastructure and industrial sectors. They do this by responding to challenges with agility and ingenuity. Their approach to servicing their customers centres on leveraging technology, a multi-disciplined and solution-oriented approach to projects and the provision of lifecycle technical services. Ampcontrol has deep, complementary engineering capabilities, established R&D teams with rapid prototyping labs and advanced manufacturing facilities.

Outcomes and impacts

Actively seeking external collaborators and running various solution streams simultaneously to maximise potential for success was the driving force behind the successful creation of a fully-functioning emergency ventilator to assist with the NSW Government COVID-19 response.

Ampcontrol designed and developed the ventilator in consultation with the NSW Government and project partners NSW Health, Safearth, NewieVentures, University of Newcastle and the John Hunter Hospital.

The emergency ventilator was developed in response to the NSW Government 'call-to-arms' in March 2020. Employing an agile approach to innovation and calling on the right collaborators with the knowledge required for such a project, a dedicated research & development team (of up to 60 members at one point) successfully delivered an initial functional prototype for testing at the John Hunter Hospital in just 18 days.

The following 3 months saw the project team further refine the prototype before manufacturing 10 pre-production ventilators for further clinical testing and submission to the Therapeutic Goods Administration (TGA) for assessment. The pre-production units were officially unveiled by the then-NSW Premier, The Hon. Gladys Berejiklian, on 9 September 2020.

"The Ventilator Innovation Project is a true partnership in action. Tackling a challenge of this size was only made possible through collaboration with local businesses, clinicians, university and Government," said Ampcontrol Executive General Manager Innovation & Service Warwick Sommer.

"To turn a concept into a fully-functional life-saving piece of medical equipment within such a critical timeframe is a testament to our region's skilled expertise and highly advanced capability to produce innovative solutions and manufacture products that make a difference to people's lives."

The Ventilator Innovation Project is the perfect example of a two-way beneficial collaboration approach that centres on Ampcontrol's existing

relationship with the University of Newcastle through the ResTech joint venture.

Established in 2004 as a collaboration between the University of Newcastle and Ampcontrol, ResTech spans both academia and industry by translating research into the tangible and valuable solutions the industry wants. ResTech's provision of hardware acceleration services are relatively unique and in high demand.

ResTech's success has demonstrated the value of research collaboration; Ampcontrol has leveraged that success to build a broad network of partners to develop innovative solutions in resources, infrastructure, and energy transition.

Responding to industry needs and challenges through innovation was the driver behind Ampcontrol's development of an electric vehicle solution for underground coal mining called DriftEx.

The operation of diesel vehicles in an underground coal mine exposes mine workers to diesel exhaust fumes. The industry is actively seeking ways to eliminate those fumes and improve workplace health and safety. In addition, the elimination of diesel machines is helping to decarbonise mining operations.

Ampcontrol's DriftEx solution, developed in conjunction with its mechanical partner Solitech, replaces the diesel drivetrain in an underground personnel carrier with an electric drive and battery system. The solution incorporates several explosion protection techniques to allow the vehicle to operate in an explosive atmosphere.

Without the extensive industry experience of both collaboration partners, the innovations within DriftEx would not be available to the mining industry.

The manufacturing of DriftEx will take place near Newcastle NSW, and will result in new jobs contributing to decarbonisation.

Lithgow Arms

Themes

- An identified need for public sector procurement to encourage manufacturing in NSW.

Company

Opened on 8 June 1912, the Lithgow Small Arms factory initially manufactured Lee-Enfield rifles for the Australian military during World War I. During World War II, production expanded to include Vickers machine guns, Bren guns and, post-war, branched out into sporting goods, handcuffs, tools, sewing machines (from the mid-1950s), the F1 submachine gun, and the L1A1 SLR.

The factory became part of the Weapons and Engineering Division of Australian Defence Industries (ADI) in 1988. ADI was sold to a private consortium owned equally by Transfield and Thompson-CSF in November 1999. Transfield's share was bought out in 2006. Since then, it has operated as part of the Thales group and is now known as Lithgow Arms. The factory continues to manufacture the EF88 Austeyr rifle currently used by the Australian military.

Size

Thales in New South Wales employs approximately 1,900 staff in eight major sites and engages with more than 450 NSW SMEs in the supply chain. 140 staff work in Lithgow.

Unsuccessful NSW public sector tender

In 2016-17 the NSW Government tendered for 'long arms' for the NSW Police Force. Thales Australia (through Lithgow Arms) submitted the F90LE (Law Enforcement) variant of the ADF's EF88/F90 rifle, which is designed and manufactured in Lithgow and tailored to the needs of police forces. In June 2017, NSW Police commissioner Mick Fuller announced a multi-million-dollar plan for US-made (Queensland imported) Colt M4 carbine semi-automatic rifles to go to about 100 Public Order and Riot Squad officers.

Identifying the Issue

In 2017, Lithgow Arms was Australia's only domestic small arms factory, and this is still the case in 2022 (though Queensland company NIOA has announced plans to develop a small arms factory to be operational in 2024).

In 2017, Lithgow Arms offered Australia's only domestically-produced police rifle, but an import (the M4) was selected. Over 2014-17 alone, Thales Australia had invested over A$4 million to build the capability of the site, and prior investment in the family of rifles went back to 1988. The family of military/police rifles made in Lithgow (variants of which are called the Enhanced F88 or EF88) date back to the 1980s, but have undergone a series of design and manufacturing improvements. Rifles like the EF 88 or F90 LE are based on an Austrian design by Steyr, but are now 95 per cent Australian content.

Outcomes and impact

This case serves as an example of a situation where a NSW manufacturing capability was not supported during the NSW procurement process. It is acknowledged that normal procurement processes will have been applied and a choice made to ensure value for money.

The value for money equation for the state is less clear, noting the potential for local manufacturers to be lost to NSW if they are unable to secure local sales. Lithgow Arms has not been deterred in this instance, investing a further $6.5 million to redevelop the facility (construction commenced early in 2022). The investment will create a new manufacturing and integration hub for the design, development and precision manufacture of next generation weapons systems for the Australian Defence Force, industrial partners and export customers.

Major contracts for the ADF (Australian Defence Force) have maintained viability of the factory, but continued product development and sales are essential to this situation continuing.

Each instance of a contract being awarded offshore when an equivalent product is made in Australia, as in the case of the M4 procurement, represents a weakening of the case to continue local NSW investment in R&D and factory modernisation. This is particularly the case for companies that have options available globally.

Conversely, local procurement applied judiciously is a powerful incentive for local manufacturing to continue R&D and expansion, with flow-on effects to supply chains and quality local jobs.

GME

Themes

- An identified need for public sector procurement to encourage manufacturing in NSW.

Company

For over 60 years, GME has been an industry leader in the RF communication technology space. GME remains a NSW-based family-owned private company, and is proudly 100 per cent Australian. GME is the only Australian manufacturer of UHF CB Radios and Emergency Beacon products, holding significant market share in these segments through an ongoing focus on innovation and technology leadership.

Size

Located in Western Sydney, GME employs more than 230 staff. The GME facility houses Research & Development, Engineering, Quality Assurance, Manufacturing, Warehousing, Sales & Marketing, Finance and Technical Service functions.

Difficulties with public sector P25 radio tenders

The *P25 radio Phase 1 standard*[5] commenced development in the United States in 1988, due to the need for federal agencies to convert existing analogue systems to encrypted digital systems with enhanced data services such as GPS location services and text messaging. There was also a need for the networks and radios to be trunking[6] capable to accommodate large volumes of radios, typically over wide areas.

P25 Phase 2 was developed to provide better spectral efficiency which has advantages in larger multi-agency, densely-populated areas, as commonly found in the USA. While Phase 2 does have advantages there are still many major Federal

Agencies in the United States which have Phase 1 terminal equipment approved for use, including the Department of Homeland Security and Department of Interior.

Identifying the Issue

GME commenced developing a P25 radio solution more than 10 years ago and have invested heavily over the years in R&D and engineering to ensure continuous improvement in GME's P25 platform. The result of GME's investment in P25 technology is the CM60 range of P25 Phase 1 radios. The CM60 can operate in both conventional and trunked mode, includes AES-256 encryption and is data capable. It is the only P25 radio designed and manufactured in Australia.

All GME CM60 radios are compliant with the Compliance Assessment Program (CAP) and conform to TIA-102 Standards[7] , as well as being FCC Parts 90/15 compliant[8]. CM60 radios are also AS/NZS 4295 (LMR) and AS/NZS 4365 (CB) compliant.

GME has received recognition of the CM60 P25 radio capability both here in Australia and overseas. In Australia, GME has successfully bid for the supply of a large number of radios to the Ergon Energy network. In the United States, the GME CM60 has been approved for the supply to both the Department of Homeland Security and the Department of Interior (DOI) supply panels.

Included on the Department of Interior (DOI) supply panel is a data variant of CM60 which was specifically designed to meet DOI requirements. The CM60-V25D is a data radio with very low standby current (<150mA), the purpose of the low standby current was to enable the radio to be powered by solar power and batteries, *GME was the only company who successfully achieved this requirement.*

Outcomes and impacts

The GME CM60 operating in P25 Phase 1 has successfully passed all requirements set out in the *NSW GRN Subscriber Unit Call Testing document.* While all tests were successfully completed, GME is still not approved on the NSW GRN due to lack of Phase 2 capability, even though most areas of New South Wales do not require Phase 2 due to a lack of concentration of radio equipment on the network.

GME has also experienced similar responses regarding Phase 2 when responding to the South Australian GRN radio request for tender, being advised that South Australia does not envisage upgrading the system to Phase 2, but does not want Phase 1 terminals just in case they do upgrade.

With the investment GME has already made into P25 Phase 1 and the common response by governments of requesting Phase 2 even when there is no plan to migrate to it, this raises the question of whether any level of government in Australia would be willing to support a sovereign NSW-developed and manufactured P25 Phase 2 product if GME were to consider investing in P25 Phase 2 radio technology.

5. The P25 Standard is a trunked radio standard developed by The Association of Public Safety Communications Officials International (APCO-25) for use with public safety organisations around the world. It is widely used in Australia for the Government Radio Network (GRN) and is the system used by police, fire and ambulance services. P25 supports both voice and data digital communications.
6. Trunked radio networks utilise computer control to automatically assign the first free available channel to each call. This is a more efficient use of the available spectrum. Trunked radio systems allow multiple groups of users to share a small set of radio frequencies without accidentally hearing or talking over each other's conversations. Trunked radio systems primarily conserve limited radio frequencies and also provide other advanced security features to users.
7. The Project 25 (P25) standard is supported by the TIA-102 suite of standards. P25/TIA-102 standards are used to design and manufacture interoperable communications equipment. P25/TIA-102 standard has gained worldwide acceptance for public safety and other industries including utilities, transport, petrochemicals and mining.
8. US Federal Communications Commission (FCC) Part 90 testing is required for radio products that fall into a licensed radio band.

Silicon Quantum Computing

Themes

- A high-profile example of how leveraging funding and resources from all sources, including the Commonwealth and state Governments, can lead to world-beating technology and local manufacturing.
- Providing targeted business support with commitment has enabled SQC to achieve world-leading milestones years ahead of international predictions.
- As a high-tech company looking to innovate and develop new technologies, SQC is heavily investing in their skills and talent pipeline from Year 10 level up.

Company

Silicon Quantum Computing Pty Limited (SQC) was formed in May 2017 by the Commonwealth of Australia, UNSW Sydney, Telstra, CBA and New South Wales Government, to develop a quantum integrated circuit. In addition to funding the 5-year technical development program, the A$83 million investment was used to acquire a portfolio of intellectual property (IP) developed over the previous 20 years through federally supported research undertaken in the Australia Research Council Centre of Excellence for Quantum Computation and Communications Technology (CQC2T), headquartered at UNSW Sydney.

Quantum computing won't just change how we use, process and understand information. It will also allow us to create faster, more efficient computers that will quickly become the world's most powerful artificial intelligence machines.

Silicon Quantum Computing's vision is to make this happen for the betterment of humankind – by creating technology at the cutting edge of science, and by using it in ways that are life enhancing, human-centred and world changing.

Location

Level 2, Newton Building, UNSW Sydney, Kensington, NSW 2052, Australia.

Size

Led by founder and CEO Michelle Simmons AO, SQC has assembled a globally recognised team of quantum scientists and engineers, coupled with business practitioners, to develop and commercialise its globally unique atomic quantum processors out of its laboratories in Sydney. SQC currently has 45 scientists and engineers and 6 corporate officers.

Operation

Silicon Quantum Computing (SQC) is Australia's first quantum computing company. It is also one of the world's leading contenders to bring a large-scale quantum computer into commercial production.

SQC's global advantage lies in its ability to manufacture high-quality quantum processors using atomic-scale components. No other company worldwide has yet been able to match this capability. Moreover, this precision is matched with a fabrication cycle that takes only 2 weeks – at least 10x faster than any competitor.

This globally unique technology, pioneered by Simmons and her team, has provided a rare opportunity for Australia to manufacture high-value quantum computing processors that can ultimately be accessed by a global market. SQC is now building a complete 'full stack' quantum computer. With tight integration of hardware design and manufacturing, and by harmonising software and algorithm development with hardware development, SQC does not need to outsource its manufacturing capabilities.

Outcomes and impacts

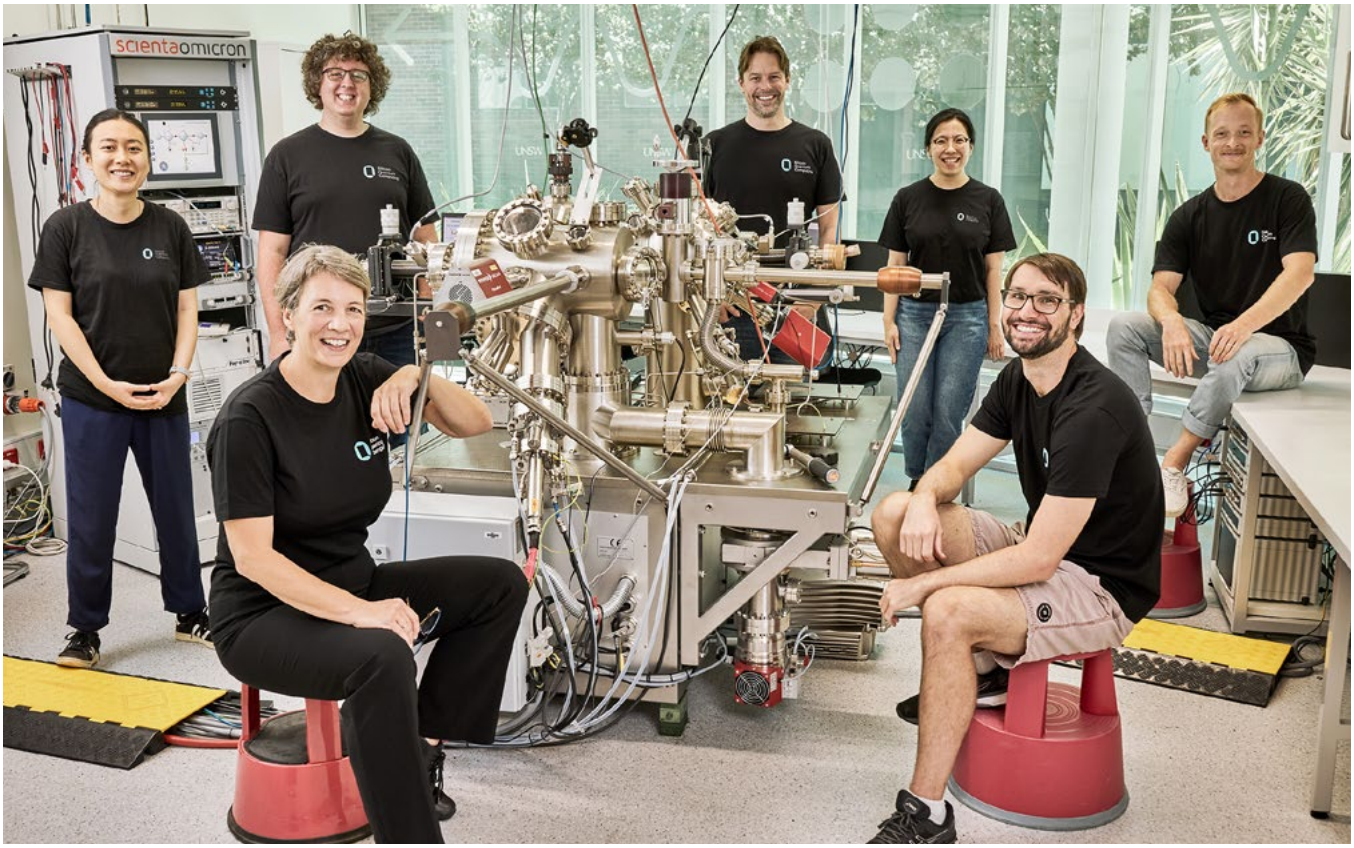
Since 2017, the SQC team has achieved a series of major technical breakthroughs, the most recent of which is delivery of an integrated circuit manufactured on the atomic scale. The company's success builds on decades of intellectual property (with 94 patents in 2022), culminating in a comprehensive process for manufacturing active electronic devices with atomically-precise component placement and atomic-level control of quantum properties.

Along the way, this team has designed and built a classical transistor where the functional part is a single atom. They have created the narrowest conducting wires in silicon, just one atom tall and four atoms wide, with the same current-carrying capacity as copper – showing that Ohm's Law continues to the atomic scale.

They have also demonstrated one of the key components of a quantum computer: a 2-qubit gate. By independently reading, manipulating and controlling the entanglement between 2 electron spins placed on individual atoms only 10nm apart, SQC has demonstrated a 2-qubit gate that functions 200x faster than any 2-qubit gate in silicon.

The company's most recent result, which is the creation of a complete quantum integrated circuit manufactured on the atomic-scale, was achieved at the end of 2021 and recently published (June 2022) in the peer-reviewed journal Nature – less than a decade after the team's 2012 declaration that it had fabricated the world's first single atom transistor, 2 years ahead of the company's schedule.

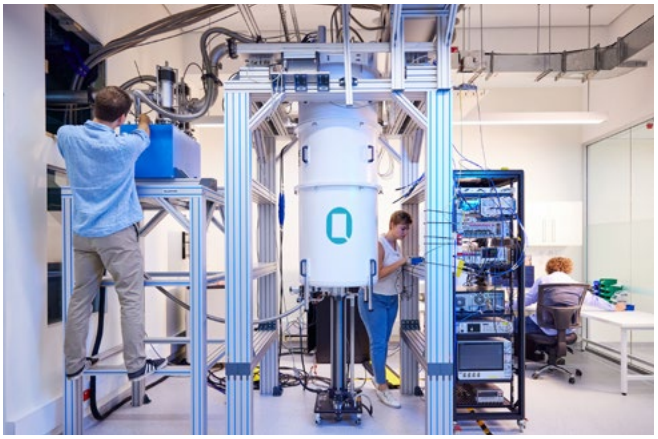
The SQC team have shown that this circuit can be utilised as a quantum analogue simulator to simulate the molecule polyacetylene. This is a very important demonstration because today's classical computers struggle to simulate even relatively small molecules due to the large number of possible interactions between atoms. It now looks as if SQC's atomic-scale circuit technology, by contrast, will allow the company and its customers to construct quantum models for a range of new materials, whether they be pharmaceuticals, materials for batteries, or catalysts.

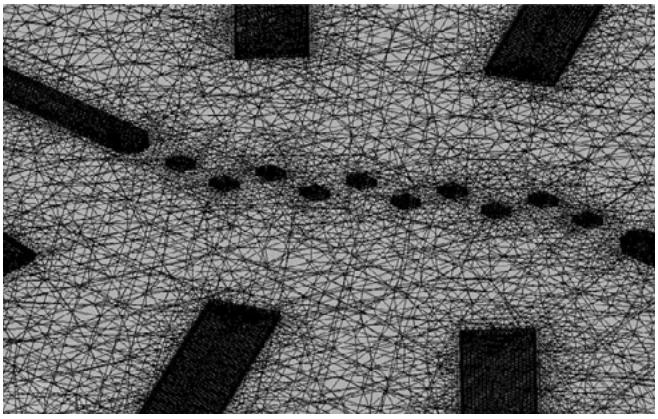


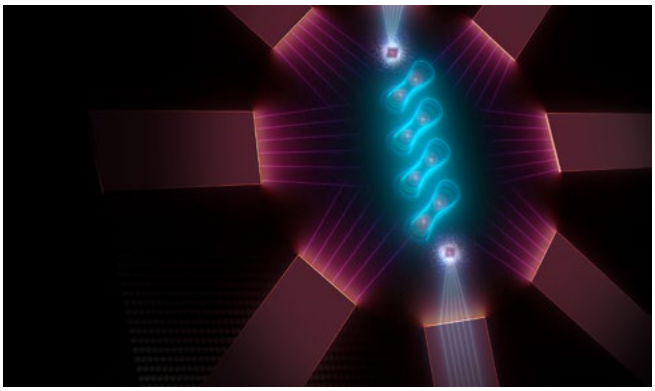
Realising a quantum simulation algorithm on a processor manufactured at the atomic scale is a huge validation of SQC's manufacturing capabilities, and a critical step on the path to developing quantum processors for quantum computing applications. It represents a seminal achievement towards a commercial quantum computer manufactured here in Australia and positions SQC for commercial growth.

From a manufacturing and industry-establishment perspective, the delivery of the world's first integrated circuit fabricated at the atomic scale is hugely significant. SQC's chip hardware team are world leaders in what they do. They have demonstrated that, with targeted support, SQC could be the first to deliver high-value quantum computing services to a global marketplace from an Australian manufacturing base.

SQC is now focused on customer partnerships and delivering the world's first commercially useful quantum processor by 2028. SQC is confident that it can achieve this ambition given its milestone-driven focus and a well-articulated technology roadmap.







Modern Manufacturing: a perspective from SQC

It is expected that quantum computing services will initially be provided to customers in a similar way to current high-performance computing services. In other words, quantum computers will be high-quality, relatively low-throughput products with customers accessing extremely high-value compute services via the cloud.

This provides a unique opportunity to manufacture here in Australia, in which respect SQC is uniquely positioned. SQC's global leadership in atomic-scale device manufacturing, the high value and sophistication of its products, and the advantages in integrating hardware, software, and service delivery via the cloud, means that SQC can manufacture competitively from Australia.

Indeed, SQC believes there are key advantages that its Australian location provides over its competitors, including proximity to an outstanding research capability, Australia's appeal to international talent, and the cultural advantages of a workforce that is not constrained by tradition and is willing to try to do things differently.

SQC's belief in the value of selling globally while manufacturing locally is demonstrated by its commitment to supporting local supply chains and skilled workforce development. Since its establishment, SQC has entered into a partnership with Sydney technology firm, Silex Systems Ltd, to secure supply of its feedstock, isotopically pure silicon 28. It is also actively addressing talent gaps in key manufacturing and software skills by upskilling graduates from related disciplines and has supported the development of a quantum computing online course for Year 10 students aligned to the Australian curriculum.

Jenkins Engineering Defence Systems Pty Ltd (JEDS)

Themes

- Coordinated program of government and industry support for skills and training, with a focus on STEM education in Australia and recruitment from 5-eyes countries.
- Specialised support for procurement given the sovereign nature and long gestation times of defence projects.

Company

Jenkins Engineering Defence Systems Pty Ltd (JEDS)

Location

Units 1,2 & 6, 1 Military Road (PO Box 327), Matraville, NSW, 2036, Australia

Size

50 employees.

Operation

JEDS is a wholly Australian-owned company that specialises in the design, manufacture and marketing of Electronic Warfare (EW) products, including software and the service and support of EW, radar and radio communications systems.

Quality Assurance: ISO 9001:2015, 45001:2018 and 27001:2013 Certified by Lloyds Quality Registration Assurance Australia

Outcomes and impacts

JEDS has supported the Australian Defence Force (ADF) since it was founded in 1989 with 2,800m2 facilities (Including Head Office) in Sydney NSW and a 1,000m2 facility in Rockingham WA (near Perth).

JEDS currently has two prime contracts directly with Australia's Department of Defence as follows:

- In-service support of the Radar EW support systems used aboard Royal Australian Navy (RAN) Destroyers, Frigates, Landing Helicopter Dock vessels (LHDs) and Submarines.
- Leading the EW component of the RAN's Collins-class submarine Communications and EW Improvement Program (CEWIP).

JEDS is also involved in two major Research and Development Programs:

- The third phase of an ongoing Federal Defence Innovation Hub (DIH) project to develop an Australian sovereign Radar EW support system for small naval and constabulary vessels.
- The second phase of a collaboration project with Macquarie University, the first phase of which was initiated through the auspices of the NSW Government's Defence Innovation Network (DIN) program with additional co-funding from the Federal Government's Research Connections program.

JEDS is one of the few companies that successfully transitioned a Defence-funded Capability Technology Demonstrator (CTD) into service aboard RAN Destroyers and Frigates. This project was for the design and manufacture of a Radio Frequency (RF) low-band Direction-Finding (DF) subsystem that was then integrated into the Radar EW Support system provided by an overseas Original Equipment Manufacturer (OEM) for RAN warships.

SUBMARINE ANTENNAS

Design

While the majority of JEDS employees are technicians providing in-service support of deployed equipment, JEDS also employs several design engineers to 'refresh' equipment already in use and to develop new hardware, firmware and software to ensure JEDS can offer the ADF the latest in EW technologies.

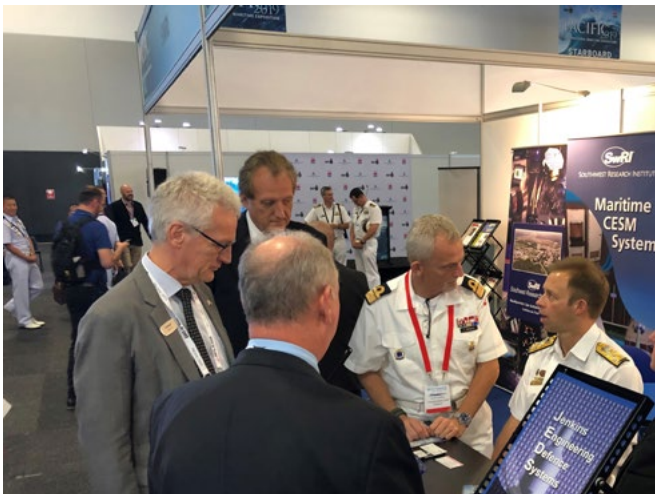
With the long gestation period of most Defence projects, Government funding support for such design work is essential to maintain cash-flow within the business.

A recent example of this was the Federal Government's intention to fund design work for the Attack-class (diesel-powered) submarine's EW system; however, this program was cancelled before JEDS' multiple-year pursuit of this work transitioned to contract – leaving the company considerably out-of-pocket.

Manufacture

EDS manufactures EW and EW-related equipment to its own designs and, not the least for Australian sovereignty reasons, seeks to source components and assistance locally within Australia and New Zealand where possible.

While JEDS does not have high-quantity output production lines, it does have several employees engaged in the manufacturing process – including their own use of 3D-printing – both for prototyping, and recently for production.



Marketing

While JEDS has a sound reputation in Australian Defence, the traditionally high turnover of personnel in ADF (and wider Defence) postings means JEDS needs to maintain its presence at Australian (and relevant international) Defence Trade Shows and Expositions.

JEDS has recently come from subsidised participation in the NSW Government Stand at recent biannual 'Landforce' and 'Air' (Avalon) shows and, pre-COVID, participated in Federal government subsidised 'Team Australia' Stands held in Europe.

Challenges

<u>Workforce</u>

- As with a number of other 'niche' capability providers, JEDS is continually challenged in trying to grow RF qualified and experienced engineers and technicians – as well as trying to source experienced (but not too expensive) software and systems engineers.
- <u>Assistance Sought.</u> JEDS would like to see more Australian Government support for Science, Technology, Engineering and Mathematics (STEM) education and training – particularly in areas relevant to Defence, e.g. RF.
- Due to National Security and US International Traffic in Arms Regulations restrictions, JEDS is largely restricted to recruiting only Australian citizens.

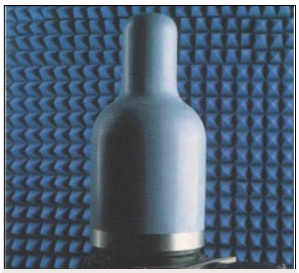
- Assistance Sought. JEDS would like to see the above STEM programs aimed at Australian nationals with the Federal/state/territory identified workforce shortages in Health and ageing being the target of immigration programs from non-5 eyes countries. This would reduce the need for Defence companies to compete with other sectors of Australia's economy that are not reliant on Australian citizens.

Marketing

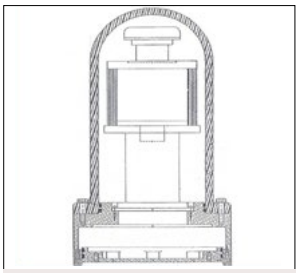
JEDS would like to see the previous level of subsidies for its participation in the large biannual Defence Trade Shows and Expositions maintained to reduce the financial impact of such participation on the company.

Manufacturing

JEDS would like to see Commonwealth and state government sponsored programs to upskill employees in relevant areas, e.g. 3D printing, to ensure JEDS can keep its workforce up to date on the latest commercial technologies and processes, thereby maintaining competitiveness – especially vs Australian Defence-related work being offshored to overseas OEMs.



1993
ESM Radome



1995
Search Periscope Antenna Unit

2001
Collins PAU

2019
Collins PAU DF

Molycop / SMaRT@UNSW

Themes

- Collaboration – Industry / Research / Government
- Leverage funding and resources from all sources, including the Commonwealth and other state programs.

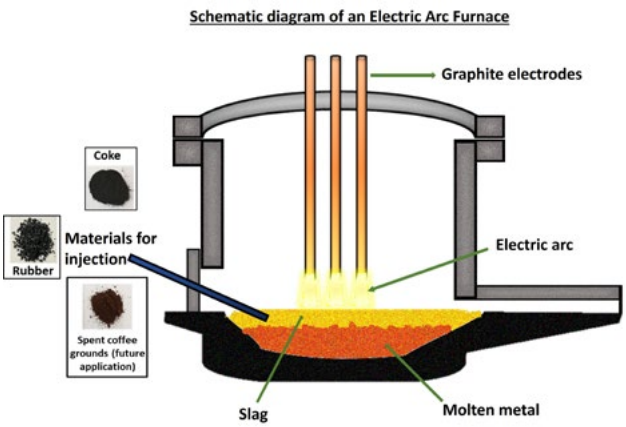
Company

Molycop is a leading global supplier of grinding media critical to mineral extraction and processing. Molycop products are manufactured in 12 operating plants globally, which support ~950 mills worldwide with a range of products and solutions. Molycop's Australian operations began as the Commonwealth Steel Company (Comsteel), which was established in 1917 in Newcastle. Through a series of acquisitions, the current Molycop facilities were purchased by American Industrial Partners in 2017. Location

Units 1,2 & 6, 1 Military Road (PO Box 327), Matraville, NSW, 2036, Australia

Location

Molycop has manufacturing and waste recovery facilities in Newcastle, Cootamundra and Perth, with office locations in Sydney, Newcastle, Melbourne and Perth.



Size

Molycop Australia employs 550 people.

Operation

Molycop operates an integrated steel plant at Waratah as well as a waste recovery service based in Cootamundra. The Molycop 360 business processes mining, industrial and council wastes which are recycled by Molycop and turned into feedstock for their steel-making operations.

Molycop uses Green Steel Polymer Injection Technology®, under licence from the UNSW Sustainable Materials Research and Technology (SMaRT) Centre, where rubber from end-of-life tyres is used as the reducing agent in the steel-making furnaces, thus decreasing the amount of coking coal required in the process.

This has the benefit of reducing the energy required, reducing the amount of waste going into landfill, reducing greenhouse gas emissions, improving production efficiency and also provides the added benefit of reducing Australia's reliance on coking coal from overseas. Despite being one of the largest coal exporters, last year Australia imported $151 million worth of coking coal from overseas, primarily from China, New Zealand and India.

Outcomes and impacts

Molycop's long-term and ongoing collaboration with the UNSW SMaRT Centre shows how economic and sustainability benefits can be born when there is **close collaboration between industry and research**. The idea of using waste materials in the steel-making process, or 'Green Steel', reached enough viability in 2011 for commercialisation. The successful trial of the idea, and its adoption into manufacturing, should be celebrated as an example of research commercialisation done right.

Leverage funding and resources from all sources, including the Commonwealth and other state programs, also lies behind the successful development and commercialisation of technology used in industry. The Australian Research Council, through the UNSW SMaRT Centre as host, jointly funded with industry including Molycop and the ARC Green Manufacturing Research Hub at the University of New South Wales. The Commonwealth Government provided funding over four years for the Hub which ran to 2020, and in 2021, the UNSW SMaRT Centre again teamed up with Molycop and other industry partners, successfully securing funding for the new ARC Microrecycling Research Hub. This is highly significant as research and industry are striving towards the same goal of reducing waste and sourcing sustainable materials for manufacturing.

The collaboration between Molycop and the UNSW SMaRT Centre continues, and in late 2021, they secured funding from the Commonwealth Government-backed Advanced Manufacturing Growth Centre to help advance commercialisation of SMaRT's 'Green Steel' Polymer Injection Technology as part of SMaRT's next generation research into Green Steel.

CSIRO – Lindfield Collaboration Hub

Themes

- Collaboration – Industry / Research / Government
- Targeted public sector support and leveraging funding and resources from all sources, including the Commonwealth and other state programs.

Company

Lindfield Collaboration Hub is an innovation incubator, supporting start-ups and SMEs to develop unique, high-tech products and devices. Early stage and established companies can move to CSIRO's Lindfield campus and access facilities, science know-how, experience, business networks and commercialisation savvy. Collaboration occurs broadly across the Australian innovation ecosystem, including with CSIRO's ON Innovation team to deliver bespoke commercialisation programs to support the development of emerging ideas and technologies.

Location

The Lindfield Collaboration Hub is co-located at the CSIRO site at Bradfield Rd, West Lindfield, NSW.

Size

The Lindfield Collaboration Hub occupies ~1300m2 of laboratory and office space and is currently home to 7 small businesses who employ a total of 50 staff. The Hub also comprises a dedicated Maker Space, which is fitted out with mechanical and electronic tools and equipment to support the fabrication, development and testing of prototype devices.

Operation

The Lindfield Collaboration Hub has been operating for 7 years, and over this time, has supported start-ups and SMEs to engage with CSIRO and the broader innovation ecosystem across NSW. Over 30 businesses employing more than 300 staff have co-located at Lindfield across a range of industries and technologies, including medical devices, communications, energy and robotics. The Hub also helps entrepreneurs and innovators refine their value propositions and business model through commercialisation and innovation programs.

Outcomes and impacts

As a delivery partner for the NSW Government's Boosting Business Innovation Program, the Lindfield Collaboration Hub has supported businesses to access and engage with R&D through co-location, access to CSIRO facilities and expertise, access to commercialisation programs (Connect@Lindfield) and building networks through events and workshops.

Co-location – Baraja Pty Ltd

Founded in 2016, Baraja began its work on a breakthrough LiDAR technique that created an elegant solution to the complex problems facing legacy LiDAR systems that give vision to self-driving vehicles. Baraja was one of the first tenants of the CSIRO Lindfield Collaboration Hub, after moving their operations to CSIRO Lindfield from their garage and scaling from 2 to over 80 employees. The development of Baraja's proprietary technology was accelerated through co-location with the CSIRO. In particular, on-site access to contract research in optical systems and electromechanical design, internal and external testing ranges, clean rooms and prototyping and mechanical services. The Baraja team have since moved to their own premises in North Ryde, where they continue to scale their operations. www.baraja.com

Commercialisation Programs – Defy-Hi Robotics

Abbie Widen, the co-founder and CEO of Defy-Hi Robotics, participated in the Connect@Lindfield pre-accelerator program in 2020. As the owner of an established and successful window cleaning company, Abbie was looking to incorporate a window cleaning robot into operations to keep team members safe and reduce downtime. Through the Connect@ Lindfield program, Abbie and her team were able to identity a clear market opportunity, connect with potential customers, build their technical team and develop a network to support the new venture. Defy-Hi robotics was the recipient of the NSW Physical Sciences Fund grant in 2021. The team are now residents of the Lindfield Collaboration Hub and have grown to 6 employees. www.defyhi.com/

Grants and Funding – Adiona

The Lindfield Collaboration Hub was a delivery partner for the NSW Government's Innovation District Challenge, which was designed to help business communities across NSW develop innovations to tackle the many challenges of COVID-19. CSIRO supported Adiona, a company developing a logistics and delivery optimisation platform, using sophisticated machine-learning techniques, to develop their submission for the grant. Adiona were named winners of the second Innovation District Challenge and were awarded a grant of $250,000 to support the commercialisation of their platform. www.adionatech.com/

Innovate to Grow – Advanced Manufacturing

Supported by Investment NSW's Boosting Business Innovation Program and in partnership with the CSIRO SME Collaboration team, the Lindfield Collaboration Hub is running a program for SMEs working in the manufacturing industry to refine their innovation ideas and develop future R&D opportunities. With the help of experienced researchers and innovation experts, participants can examine their technical and/or business challenges, explore their R&D and innovation opportunities, and develop actionable business and funding plans. www.csiro.au/en/work-with-us/funding-programs/SME/Innovate-to-Grow

For more information on the Lindfield Collaboration Hub contact Katie Green katie.green@csiro.au or visit www.research.csiro.au/lindfieldhub/

Selected quotes from Hub members:

"Hardware is very different to software and so access to the Maker Space has been great. That has let me get started without having to buy my own equipment in a lot of cases."

–[CSIRO Lindfield Collaboration Hub]

"You need somewhere where you can do your prototype manufacturing and your R&D, and that's what Lindfield's perfect for."

–[CSIRO Lindfield Collaboration Hub]

"Having access to other founders, you have a camaraderie there because you're all sharing the pain, so to speak."

–[CSIRO Lindfield Collaboration Hub]

"It's a very collaborative and free-thinking environment, and that's the most important thing about it."

– [CSIRO Lindfield Collaboration Hub]

" ...You couldn't write a better story... the quality of the laboratories and access to CSIRO scientists in the physics field has been critical...Lindfield also has the only distance range for calibrating LiDAR in Australia..."

–[CSIRO Lindfield Collaboration Hub]

"Being a part of the group of scientists, engineers and entrepreneurs at CSIRO Lindfield gives our Movandi Australia team camaraderie, support, and access to facilities and social events they would not otherwise have. From a technology perspective, we benefit greatly from having access to an anechoic chamber, RF test equipment and technical experts steps away from our office."

– [CSIRO Lindfield Collaboration Hub]

University of Wollongong – Modern Manufacturing

Themes

- Circular industrial economy
- Collaboration – Industry / Research / Government
- Skills and talent
- Promotion
- Targeted business support
- State/Commonwealth Cooperation

Company

The University of Wollongong is a leading global university, powered by its people, partnerships and communities. Our vision is to inspire a better future through education, research and partnership.

Our ambition for our graduates is that they will be ethical, agile thinkers who are competitive in a global economy, and that their experiences at UOW will shape their sense of self as well as their future career.

- Top 1 per cent of universities worldwide (QS World University Rankings 2023)
- Top 20 -14th best modern university in the world (QS Top 50 Under 50 Rankings 2021)
- 1st in Australia for graduate employer satisfaction (QILT Employer Satisfaction Survey 2021)

Location

Northfields Ave Wollongong, NSW, 2522 Australia. UOW works across various industry and partner locations throughout the Illawarra, with a global network of campuses and partners.

Size

Since establishing our university campus in Wollongong in 1975, we have expanded our teaching locations to a network of 12 UOW campuses and a number of global partners, delivering world-class research and education.

Australian campuses

Our domestic campuses are located in Wollongong, regional centres and Sydney. You can find where your preferred course is offered by searching Course Finder.

Wollongong

UOW's Wollongong campus is set in native Australian bush and is one of the most picturesque university campuses in Australia. Less than two kilometres east is UOW's Innovation Campus – a research and technology precinct that houses innovative organisations as well as some of UOW's leading research institutes.

- Wollongong
- Innovation Campus

Regional

In 1993 UOW established the first of its regional campuses in the Shoalhaven. Since then, the network has been extended so that residents of other regional areas can benefit from a university education close to home.

- Batemans Bay
- Bega
- Shoalhaven (Nowra)
- Southern Highlands (Moss Vale)

Sydney

UOW has two campuses in Australia's largest city, Sydney, and a new campus in one of Australia's fastest growing urban areas, Liverpool.

- Southern Sydney (Loftus)
- South Western Sydney (Liverpool)
- Sydney CBD (Circular Quay)

International campuses and teaching locations

Beyond Australia, UOW has campuses in the United Arab Emirates (Dubai), Hong Kong, Malaysia and a presence in China and Singapore. UOW has also established partnerships with a number of international education institutions to provide students with opportunities to access quality education delivered by UOW outside Australia.

UOW campus locations

- Central China Normal University (CCNU), Wollongong Joint Institute
- UOW Malaysia KDU
- UOW College Hong Kong
- University of Wollongong in Dubai

Transnational education partners

- PSB Academy, Singapore
- The Singapore Institute of Management (SIM)

Twinning arrangements

- Beijing Jiaotong University
- Zhengzhou University
- Tianjin Polytechnic University
- Central China Normal University
- Taiyuan University of Technology

International linkages

We have formal agreements with more than 400 overseas institutions in 45 countries spanning research collaborations, teaching collaborations, credit arrangements, articulation arrangements, study abroad and exchange programs, and offshore program delivery. UOW connects people who want to learn and improve the world around them.

Operations

The University of Wollongong (UOW) is working closely with industry, research partners, governments, universities and VET providers to develop Australia's circular industrial economy, reduce emissions, equip an appropriately skilled workforce for sustainable change, and provide solutions to support existing and emerging businesses as they look to adopt modern manufacturing technologies and innovative systems.

UOW is working toward an inclusive clean energy future-energy transformation that accommodates social, economic and technical issues. Energy transformation has regional significance to the Illawarra as manufacturing and mining operations in the region are investigating clean energy options. There is a substantial skills base in manufacturing and mining, providing plenty of opportunity for retraining and transitioning of the workforce.

As part of this, we are working closely with the NSW Government, the Future Fuels CRC, industry, and energy suppliers to develop a vibrant hydrogen industry in the Illawarra. As co-hosts of the Future Fuels CRC, UOW is placed at the forefront of alternative fuel development, particularly hydrogen. UOW has developed a high-pressure pipeline testing laboratory that allows testing of pipeline technology for future fuel transport, including hydrogen. This laboratory is one of only a handful available globally.

Along with world-class research facilities, UOW has a proven track record of commercialising research. In a clean energy breakthrough, researchers from UOW, the ARC Centre of Excellence for Electromaterials Science (ACES), and UOW's Intelligent Polymer Research Institute (IPRI) have developed new electrolyser technology that brings cost-competitive renewable, or green, hydrogen closer to reality.

The team's "capillary-fed electrolysis cell" produces green hydrogen from water at 98 per cent cell energy efficiency. This productivity is superior to

other existing electrolyser technologies and is well above the International Renewable Energy Agency's (IRENA) 2050 target, enabling an affordable hydrogen production cost that can match the production costs of fossil fuels. Inexpensive green hydrogen is needed for the decarbonisation of many industries. Electrolysers, which use electricity to split water into hydrogen and oxygen, are the key technology for producing green hydrogen.

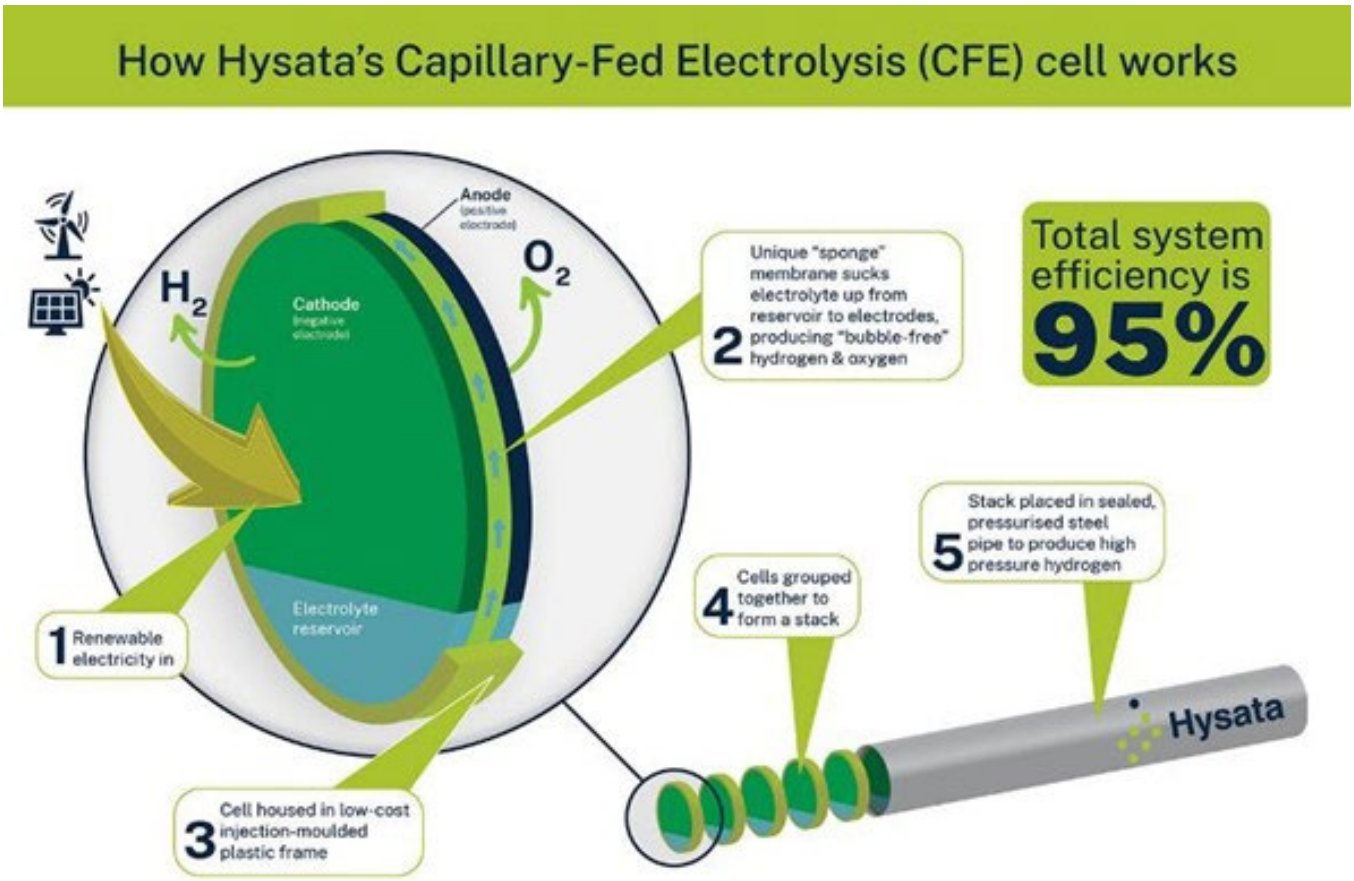
Outcomes and impacts

Hydrogen technology commercialised

A company spun out from UOW is working to commercialise breakthrough Australian hydrogen electrolyser technology that brings cost-competitive green hydrogen closer to reality. In July 2021, Hysata was launched with $5 million in seed funding led by IP Group, with support from the Australian Government's Clean Energy Finance Corporation (CEFC). In August 2022, the company raised a further $42.5 million in a Series A funding round.

The world-leading electrolyser is based on breakthrough technology developed by a team from the UOW-headquartered ARC Centre of Excellence for Electromaterials Science (ACES).

The company's overall electrolyser system has been designed for ease of manufacturing, scaling and installation, delivering 95 per cent overall system efficiency, equivalent to 41.5 kWh/kg, compared to 75 per cent or less for existing commercial electrolyser technologies. For hydrogen producers, this will significantly reduce both the capital and operational costs to produce green hydrogen.



For more details: https://hysata.com/, https://www.uow.edu.au/media/2022/breakthrough-opens-door-to-low-cost-green-hydrogen.php, and https://www.nature.com/articles/s41467-022-28953-x

The company's electrolyser will deliver the world's lowest cost green (renewable) hydrogen, saving hydrogen producers billions of dollars in electricity costs, and enable green hydrogen to outcompete fossil fuel-derived hydrogen. The technology will enable hydrogen production below US$1.50 per kilogram by the mid-2020s, meeting Australian and global cost targets much earlier than generally expected. This is critical to making green hydrogen commercially viable and decarbonising hard-to-abate sectors.

ARC Research Hub for Australian Steel Innovation (Steel Research Hub)

UOW headquarters the ARC Research Hub for Australian Steel Innovation - the Steel Research Hub (SRH), which is focused on decarbonisation opportunities for the steel industry. The second Steel Research Hub commenced in late 2021, following the completion of the first hub earlier that year.

The new SRH has eight industry partners, including BlueScope Steel, and brings together teams of internationally recognised research and industry talent to deliver innovative solutions and breakthrough technologies in steel manufacturing and product development.

The $28 million research program is designed to support the transition of Australia's steel manufacturing industry to a more sustainable, competitive and resilient position, based on the creation of new, higher value-added products and more advanced manufacturing processes.

The hub's four research programs are:

- Process integration and sustainability
- Product innovation and technology
- Advanced corrosion performance and operational efficiency
- Steel supply chain transformation.

Product innovations in the first SRH included a project to develop a self-cleaning, antimicrobial organic coating for painted steel to prevent the build-up of mould, algae and other bacteria on steel surfaces.

A joint research team comprising members from UOW, BlueScope Steel and the University of Queensland investigated the challenge of producing smooth, uniform, thin metallic alloy coatings on high-quality coated steel products. Coated steel products - such as corrosion-resistant metallic alloy coated steels - are important for Australian steel manufacturers, particularly in building applications that must withstand harsh climate for extended periods.

Another project from the first SRH focused on the sustainable recovery and utilisation of iron and flux units from steelmaking dust. Maintaining a strong social and environmental perspective is an essential requirement of modern steelmaking.

Other case studies demonstrating outcomes from Steel Research Hub 1 can be found at www.uow.edu.au/steel-research-hub/previous-steel-research-hub-2014-2020/

Innovation in 3D bioprinting

The Translational Research Initiative for Cellular Engineering & Printing (TRICEP) at UOW draws on expertise and facilities available within the ARC Centre of Excellence for Electromaterials Science (ACES) and the Australian National Fabrication Facility (ANFF) Materials Node to connect research and industry to develop innovative technologies using 3D bioprinting.

The TRICEP team has a strong track record of identifying and customising materials and fabrication protocols to deliver 3D bioprinting and biomaterial solutions. The team is also involved in growing research and industry activity in marine bioresources. As part of this, TRICEP is working to accelerate commercialisation opportunities in 3D bioprinting of seaweed molecules. Researchers have been collaborating with Venus Shell Systems for a number of years. TRICEP's partnership through the Marine Bioproducts Cooperative Research Centre (MB-CRC) is helping researchers to develop, refine and validate marine bioproducts in an environmentally and economically sustainable way.

Cutting-edge technology that the TRICEP team has developed includes the BioPen for cartilage regeneration, the iFix Pen to treat corneal ulcerations, and 3D Genii printer, which is designed to print implantable, flexible, customised prosthetic ears

that match the anatomy of patients suffering from microtia (a congenital deformity of the ear).

More information on TRICEP can be found at www.tricep.com.au/ and www.uow.edu.au/media/2021/funding-boost-to-research-into-seaweed-for-clinical-applications.php

BlueScope Cadetship Program

From its earliest beginnings, the University of Wollongong (UOW) was formed in partnership with industry. A cadetship program established at BHP and then BlueScope has spanned 43 years and continues to develop an outstanding group of leaders.

The strength of this relationship has continued despite changing economic conditions over the years. The combination of industry employment and university education provides fertile ground for fostering leaders across many industries. More than 600 UOW alumni have completed the cadetship.

BlueScope Steel's Port Kembla Steelworks offers a number of cadetship positions every year for UOW students studying Materials Engineering, Mechanical Engineering, Mechatronic Engineering or Electrical Engineering. This program is very competitive and targets high performing students in their first, second or third years of study (although promising HSC students are also considered). The annual intake of cadets is between 10 and 15 students per year, and BlueScope currently has approximately 50 students in its cadetship program.

As cadets, undergraduate students are required to work 30 hours per week for BlueScope, and are provided with one day each week to attend classes and focus on their studies. As it is not always possible to schedule all classes on one day, this arrangement is flexible, and students are given the opportunity to attend classes and tutorials during the day as long as they work the required number of hours per week. Each cadet is assigned a cadet coordinator within BlueScope to oversee their academic progress and provide them with career guidance.

This arrangement is highly symbiotic, and benefits BlueScope, UOW and the cadets. BlueScope not only gets access to top students early on in their studies, but also to young graduates who are experienced, well trained and knowledgeable about BlueScope's operations. Students are afforded the opportunity to gain invaluable experience while studying part-time and earning a salary.

As the cadetship can be cancelled if a student does not perform well academically, students have an added incentive to achieve high marks. In turn, the cadetship program attracts high performing students to UOW and has served as a very successful recruitment tool for Materials Engineering and other relevant engineering disciplines over the years, attracting top students to the major. They bring a level of maturity and practical expertise to the classroom that benefits all students.

Cadets are rotated through various departments to gain an appreciation of all aspects of the steelmaking process. As part of their rotation, cadets gain experience in project management, health and safety, human resource management, plant maintenance, quality management and laboratory analysis. Students are gradually given more responsibility, reinforcing their management and leadership skills. It is not uncommon to see BlueScope cadets managing teams and taking up leadership positions within the company. Many cadets go on to full-time positions within BlueScope before completing their degrees.

In addition to promoting the cadetship program to potential students, UOW actively attempts to accommodate BlueScope cadets as much as possible. As part of their degree program, all engineering students have to obtain at least 12 weeks of approved professional experience in a relevant industry. This is formalised in the form of a 0 credit point subject, ENGG454 Professional Experience, which forms part of the core program of all Bachelor of Engineering (Honours) degrees. As BlueScope cadets work part-time, they are allowed to take ENGG255 Professional Option 2 instead of ENGG454 and use a BlueScope project from their cadetship to gain credit in this subject. As ENGG255 is a six credit point subject, this subject effectively replaces one elective.

In addition to the cadetship program, BlueScope also makes a number of summer internship placements available every year. These placements are crucial for students who are not on the cadetship program, helping them to gain the pre-requisite hours towards their professional experience.

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Investment NSW | 52 Martin Place Sydney NSW 2000
GPO Box 5341, Sydney NSW 2001

Office hours:
Monday to Friday
9:00am - 5:00pm

T: (02) 4908 4800
E: via investment.nsw.gov.au/contact-us
W: investment.nsw.gov.au

Any correspondence regarding this independent report should be directed to Investment NSW using the contact details above.