MANUFACTURING COMPETITIVENESS PLAN 2022

TRANSFORMING AUSTRALIA FROM LUCKY TO SMART

AMGC
ADVANCED MANUFACTURING
GROWTH CENTRE LTD

> The Advanced Manufacturing Growth Centre's Manufacturing Competitiveness Plan* is an insightful report that will help boost capability, while developing global opportunities for Australia's manufacturing industry. As Australia's Chief Scientist, I will support the work of the Advanced Manufacturing Growth Centre.

Dr Alan Finkel, Australia's Chief Scientist (2016-2020)

* The 2022 ***Manufacturing Competitiveness Plan*** contains minor updates from the foundational Sector Competitiveness Plan published in 2017, found on amgc.org.au. Most of the data included in this report is republished with only limited new content.

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COMPANIES (including through alumni)

A&I Coatings
ACS Australia
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Innovative Manufacturing CRC
Manufacturing Skills Australia
University of New South Wales
University of Technology Sydney
Western Sydney University

FOREWORD

This Manufacturing Competitiveness Plan charts the way forward as Australia continues to build strong, export-oriented advanced manufacturing capabilities. This is vital to the nation's long-term prosperity and resilience.

The Advanced Manufacturing Growth Centre (AMGC) was established by the Australian Government in 2015 as a key part of its Industry Innovation and Competitiveness Agenda.

AMGC published its first Competitiveness Plan in 2017 based on extensive research into the state of manufacturing in Australia, its strengths and weaknesses, and how the country could best compete globally in the future. Since then, we've evolved from referring to this document as a Sector Competitiveness Plan to the Manufacturing Competitiveness Plan. This reflects the realisation that manufacturing is not a sector but a capability that cuts across every industrial sector of the economy in which something is made.

The plan has proven to be a foundation for AMGC's work and a guide for business leaders and governments as they have set their strategies and policies. Those policies include the Australian Government's $1.3 billion Modern Manufacturing Strategy, with its six National Manufacturing Priorities focused on resources technology and critical minerals processing, food and beverages, medical products, recycling and clean energy, defence, and space.

A key idea demanded in this plan is that Australia needs to compete by manufacturing high-value items that are essential to global supply chains, rather than on cost. One of many examples of this thinking in action is the country's success in becoming a world leader in making carbon fibre components that feature in jet planes and sports cars.

The plan highlights various ways for Australia to create value along the entire manufacturing value chain, noting that it spans from the research and design phase and ends with sales and service. It also discusses the importance of focusing on the right markets and making the manufacturing industry more resilient to cope with inevitable ups and downs.

Ultimately, this plan is about how to grow Australia's prosperity by making complex items. This is particularly important where the nation is a major supplier of the raw materials needed to produce products, such as the lithium required to create batteries. This is just one of many areas of opportunity for Australia, which has a burgeoning battery and energy storage sector and the potential to build a globally competitive industry with more value creation onshore and opposite to "dig and ship".

COVID-19 has raised the desire for Australia to possess local manufacturing capability. AMGC was pleased to support efforts to overcome supply chain shortages by working with the Australian Government to establish the COVID 19 Manufacturer Response Register to connect suppliers and customers.

The role of manufacturing has been highlighted in recent AMGC research. The *Perceptions of Australian Manufacturing* report published in late 2021 found that 72 per cent of Australians believe manufacturing is 'important' or 'very important' to the economy. This is up from 65 per cent in 2019 and reflects the scale of the industry, which contributes more than $110 billion a year to the economy and employs approximately 1.27 million people directly and indirectly – or about 10% of Australia's workforce.

AMGC has been especially pleased to help bring the ideas outlined in this plan to life by working on commercialisation and capability-building projects with dynamic manufacturing businesses around Australia.

Over its first five years, AMGC provided $19.6 million in grants to fund more than 100 projects. These funds have been matched by more than $100 million in contributions from industry and have driven projects supported businesses in areas as diverse as advanced composites and materials, 3D printing, robotics, virtual reality, digital design and rapid prototyping. These initiatives are forecast to deliver more than $1.4 billion in new revenue and 3,500 jobs for Australia. In addition, AMGC continues to manage $30 million in Commercialisation Fund grants under the Modern Manufacturing Strategy.

Australian manufacturing, correctly defined and measured as well as broadly understood, has a bright future. The nation has immense natural resources and energy supplies, a skilled and creative population, and many opportunities in the digital era. But it must embrace that future with the right strategies and policies. AMGC hopes this plan continues to help and further inform this effort and encourages readers to explore the wealth of our other research available on AMGC's website.

Dr Jens Goennemann
Managing Director
Advanced Manufacturing Growth Centre Ltd

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> It is essential that any analysis of competitiveness looks beyond product cost.

1 EXECUTIVE SUMMARY

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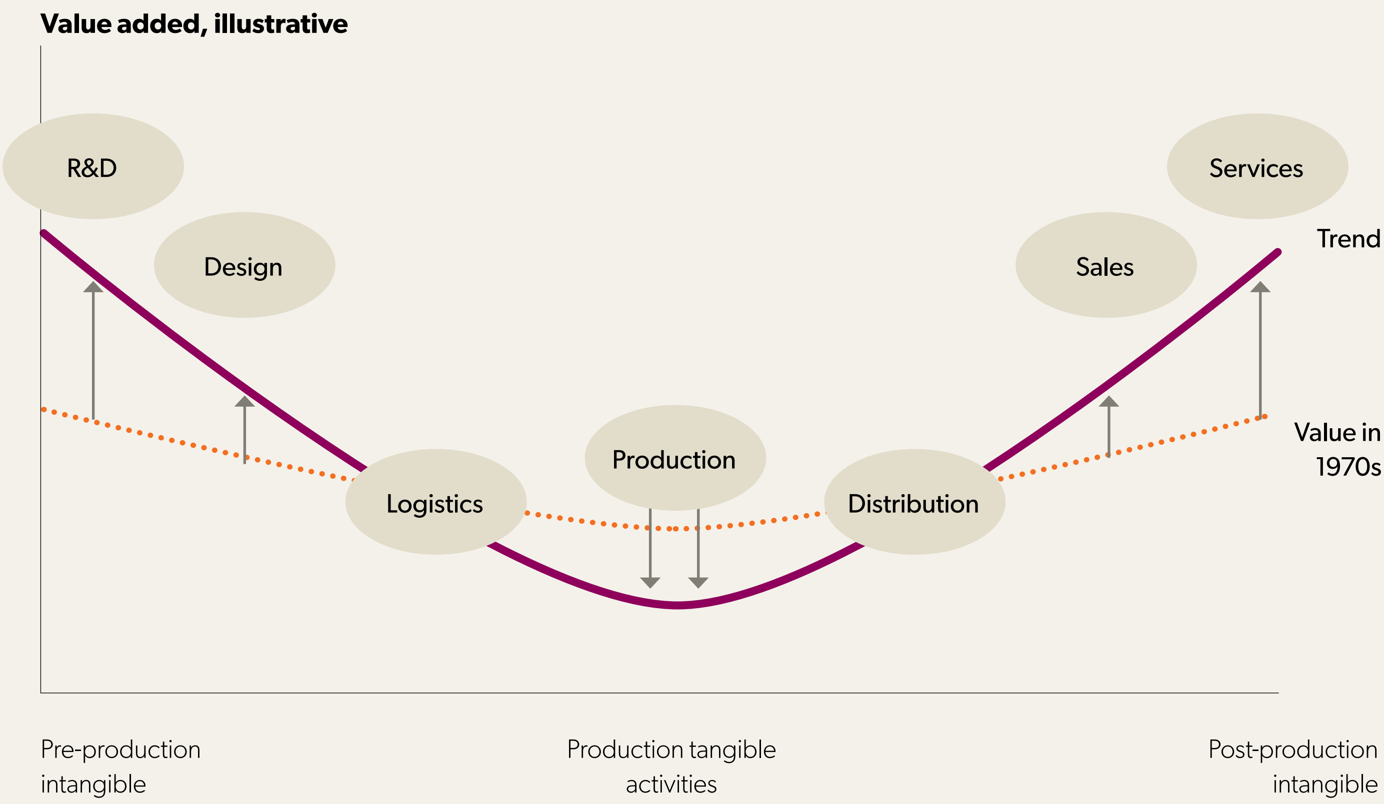
1.1 BACKGROUND

Manufacturing has a vital role to play as Australia seeks to create an innovative, competitive and globally oriented economy. Today, the industry is undergoing a historic transformation across the world. The most aspirational firms are diversifying their value propositions by tailoring unique components, services and solutions within global supply chains. As shown in the so-called 'smiley curve' (see Exhibit 1), the aim is to add value both before and after goods are produced – in areas such as research and development (R&D), design, logistics, sales and service. Work practices are also changing. Digital transformation of the manufacturing process is ushering in exciting techniques such as 3D printing, where physical objects are created from virtual templates. Connected 'smart factory' environments allow customer feedback to loop back and inform product development in real time.

Exhibit 1 – Value in manufacturing is shifting from production to pre- and post-production intangibles such as R&D and Services



Source: Curve adapted from: 'Interconnected economies benefiting from global value chains', OECD 2013

These changes offer an opportunity for Australia, if the nation is bold enough to seize it and bring manufacturers along – from the large businesses to the almost 95% of firms that employ 20 people or less in both city and regional areas around the country.

Established in 2015, the Advanced Manufacturing Growth Centre (AMGC) is a not-for-profit organisation, distinct from but supported by the Australian Government. It has been created to champion Australia's manufacturing transformation. The aim is to create a dynamic, globally competitive industry – one that will be a source of long-term economic growth and high-wage jobs.

Originally published in 2017 and then updated in 2020, AMGC has created a 10-year Manufacturing Competitiveness Plan, with input from companies and industry associations, research organisations and the federal and state governments. Its purpose is to take a strategic look at Australian manufacturing to:

- Identify and analyse opportunities to lift competitiveness.
- Establish actions for companies, governments and research organisations to realise these opportunities and transform the manufacturing industry.
- Articulate the role of AMGC in facilitating this transformation and mobilise diverse stakeholders around this national challenge.

> In the wake of the COVID-19 crisis, the appreciation for being able, as a country, to make things has clearly increased.

1.2 THE IMPACT OF COVID-19

Throughout COVID-19, we have witnessed a truly impressive response from Australian manufacturers. Manufacturers stepped up to help, focused on areas of critical need such as ventilators, hospital beds and PPE. The dedication and enthusiasm of manufacturers across the nation in reacting to the crisis has underlined precisely the strength, agility and collaborative nature of Australia's manufacturing industry.

One of AMGC's key findings in the *Public Perceptions Report* is that almost three quarters (72%) of Australians believe manufacturing is either important or very important to the economy, up from 65% in 2019. This increase reflects a renewed appreciation of the value of a strong manufacturing capability during COVID-19 and for Australia's future.

In the wake of COVID-19, the appreciation for being able, as a country, to make things has increased. This presents the Australian manufacturing industry with the opportunity to further ignite the country's capabilities, add more value onshore, and become more globally competitive.

Challenges faced by manufacturers

COVID-19 continues to impact Australian manufacturers. Global supply chains have been severely disrupted with access to raw materials and reliable shipments becoming increasingly limited. These disruptions have been exacerbated by port congestion and union activity. As a result, there have been significant cost increases for raw materials, as well as freight. These market conditions have seen a renewed appetite for expanded domestic capability and for the re-shoring of manufacturing activity.

International border closures in the wake of COVID-19 have intensified skilled labour shortages, particularly in manufacturing. Manufacturers have repeatedly given AMGC feedback that finding qualified trades people is a challenge and having access to a pool of apprentices is limited. The shortages are amplified in the regions.

Furthermore, manufacturers have expressed that the ever-changing disjointed rules, restrictions, and various roadmaps to negotiate—particularly those businesses that operate across state-borders—are making commercial decisions difficult.

1.3 REDEFINING ADVANCED MANUFACTURING

Advanced manufacturing is currently defined by the Australian Government as "any manufacturing process that takes advantage of high-technology or knowledge-intensive inputs as an integral part of its manufacturing process". The Government further stipulates that advanced manufacturing includes chemical and medicinal manufacturing, as well as vehicle and transport, professional and scientific equipment, computer and electronic, and specialised machinery and equipment manufacturing. In other words, only a few select industries are considered advanced.

However, AMGC's analysis, published in 2017, of more than 3,000 global manufacturing companies has found that belonging to a certain sub-industry, whether or not this industry is officially classified as 'advanced', says little about a company's ability to compete and remain profitable. Informed by this research, AMGC reconsidered what it means to be an advanced manufacturer in its 2017 report *Advanced Manufacturing: a New Definition for a New Era*.[1] This found that manufacturers across the developed world succeed not because they make certain products, but because they have adopted sophisticated value chain structures and production techniques. They typically use a combination of three factors to remain competitive: advanced knowledge, advanced processes and advanced business models.

This broader conception of manufacturing recognises that there is no hard line separating advanced manufacturers from others; degrees of advancement are possible in every single industry. Another benefit of moving beyond a narrow focus on production is to include workers along the value chain in research and development (R&D) and design, logistics, and sales and service occupations. These are people who serve manufacturing indirectly but are now, in many cases, employed in supporting companies. Properly accounting for them increases the size of Australia's direct and indirect manufacturing workforce to an estimated 1.27 million: significantly more than the 912,500 currently counted by the Australian Bureau of Statistics (ABS)[2].

Modern Manufacturing Strategy

The Australian Government announced the Modern Manufacturing Strategy in October 2020, as part of the national COVID-19 JobMaker plan. The Strategy is designed to help Australian manufacturing scale-up, become more competitive and resilient – creating jobs now and for future generations.

The $1.3 billion Modern Manufacturing Initiative (MMI) forms a crucial part of the Modern Manufacturing Strategy. The MMI will support projects across six National Manufacturing Priorities that reflect Australia's competitive advantages and emerging areas of priority, including:

- Medical Products
- Space
- Resources Technology and Critical Minerals Processing
- Food And Beverage
- Recycling And Clean Energy
- Defence

The National COVID-19 Coordination Commission (NCCC) Manufacturing Taskforce encouraged Federal Government to focus on those manufacturing verticals in which Australia possesses already or endeavours to possess competitive or desired advantages.

1 Australian Manufacturing Growth Centre, *Advanced Manufacturing. A new definition for a new era,* 2017. Available at: https://www.amgc.org.au/wp-content/uploads/2018/11/Advanced-Manufacturing-a-new-definition-for-a-new-era.pdf

2 Industry value and workforce figures derived from: Australian Bureau of Statistics, Detailed Labour Force, cat. no. 6291.0.55.003, May 2017. Available at: www.abs.gov.au/ausstats/abs@.nsf/mf/6291.0.55.001, and ABS, Australian System of National Accounts, Gross Value Added by Industry, cat. no. 5204.0, October 2017. Available at: http://www.abs.gov.au/ausstats/abs@.nsf/mf/5204.0

1.4 IMPROVING AUSTRALIA'S MANUFACTURING COMPETITIVENESS

AMGC is committed to strengthening Australian manufacturing's competitiveness and resilience – two key pillars that will determine the industry's future success. Australia's manufacturing industry was worth $100.8 billion in gross value added or output terms, in the year to June 2017. Analysis of the potential 'size of the prize' from improving manufacturing competitiveness suggests that Australia should aim to capture a 25–35% increase in value added by 2026 (see Exhibit 2).[3]

Studies of the manufacturing industry tend to focus primarily on cost as the key driver of competitiveness. However, AMGC's research shows that when international customers choose to purchase from an Australian company rather than a cheaper or geographically closer competitor from another country, they are usually doing so because the Australian product offers something different. Examples include ResMed's capturing of 40% of the global market for sleeping disorder devices, or Cablex carving out a niche in tailoring cable harness solutions for small runs of aircraft.

AMGC's *Public Perceptions Report* also demonstrates that 58% of Australians are happy to pay more for products made in Australia, because they believe they will be high quality. Most Australians (80%) think it is important to buy products that are Australian made, where possible. Almost two-thirds (63%) of those surveyed also believe Australian-made products are of higher quality than imported products.

Australia's high-wage economy and distance from global markets mean that its manufacturers often succeed by being better, not just cheaper, than their competitors.

AMGC has accordingly developed a new competitiveness framework that distinguishes between three strategies to improve a manufacturer's competitiveness (see Exhibit 3 on page 9)

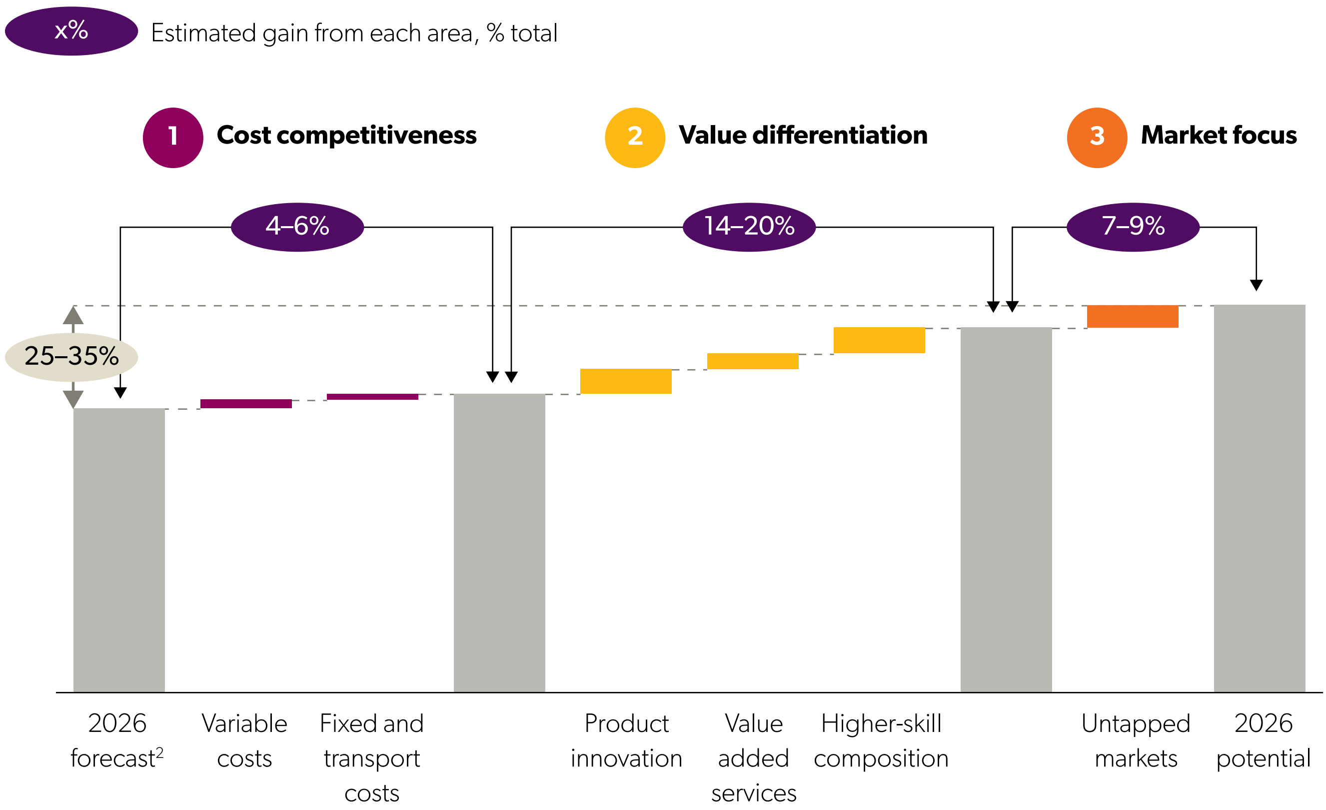
1. **Product cost:** Challenging the conventional wisdom, AMGC's analysis finds that improvements in cost competitiveness would account for the smallest component of the potential uplift, at 4–6%. Australia has a product cost disadvantage compared to other nations including the US (which we focus on in this report), based largely in part on differences in labour costs, transport costs, capital efficiency and overheads. However, there are ways to turn this around. Australia has room to capitalise on its cost advantage in high-skilled labour by transitioning its manufacturing workforce to include a greater share of people with university degrees. Australians firms can also lift their competitiveness in capital efficiency and overheads by improving management quality and collaborating more to overcome the scale challenges caused by small-firm size. Finally, increased productivity through higher capital intensity, automation and digitalisation can help the industry reduce costs.
2. **Value differentiation:** The sources of value creation for customers beyond product cost, such as innovative design, technical leadership, an exceptional reputation for reliability, or an outstanding after-sales service offer. AMGC's analysis finds that more than half of the potential increase in Australian manufacturing's value added by 2026 (14–20%) could come from companies sharpening their value differentiation strategies. This will require bold action to upskill the industry, boost industry-research collaboration, develop value-added services associated with manufactured goods, and invest more in R&D. Currently, Australia is an international outlier due to its relatively low reliance on 'direct' assistance to manufacturers such as innovation grants. By contrast, the present calibration of the Australian Government's R&D Tax Incentive fails to ensure that public expenditure goes towards R&D activity that would otherwise not have occurred.
3. **Market focus:** The ability of Australian manufacturers to boost their competitiveness by serving growing customer segments or markets, and focusing on skill-intensive product niches. AMGC's analysis finds that a stronger market focus could lift the industry's output by 7–9%.[4] Some Australian manufacturing sub-industries currently underserve several key export markets, particularly destinations for intermediate goods. The nation's firms are also poorly connected into global value chains, possessing among the lowest level of backward linkages among the OECD (Organisation for Economic Co-operation and Development).

3 The base case size of manufacturing in 2026 uses the 2006–14 compound annual growth rate as the average annual growth rate through to 2026. For detailed methodology of this estimate, see Section 3.2 and Annex B.

4 The estimated increase through market focus involves closing the gap in select sub-industries in export markets where Australia is underweight relative to Australia's average share for that product category and shifting product mix to more skill-intense sub-industries, where Australia is underweight relative to the US.

Exhibit 2

Estimated potential value gain across advanced manufacturing
Percentage of value added in 2026 relative to straight-line trend projection[1]



Notes
- Benchmarking 'landed' product cost against other high-cost countries revealed a 9–14% cost gap
- Improvement estimates based on different scenarios of closing the cost gap and either banking savings as profit or passing through lower prices
- Value estimate triangulated through assessing sub-category export improvement potential in each vertical, and through comparing firm-level profit margins for highly innovative vs average firms
- Product focus from matching US proportion in high skill industries
- GVC integration based on uplifting exports in key markets to Australian average category share.

1 Increase based on extrapolation from aerospace and med tech analysis.
2 Base growth projected using 10-year historic CAGR for ANZSIC sub-divisions 18, 23 and 24. See appendix for full methodological details.
Source: AlphaBeta/McKinsey analysis

Exhibit 3 – Competitiveness in manufacturing is driven by three factors

Three sources of competitiveness	Examples of ways to drive competitiveness, as explored in this Plan
1 Reduce cost	Manufacturers can increase their competitiveness by reducing their costs. For example: – Manufacturers can reduce their costs by reducing the **cost of their inputs**, such as transport, energy and materials, etc. – More **advanced production techniques** that enable greater output with existing resources can improve efficiency and reduce costs per unit – Manufacturers can reduce their costs per unit by **increasing their scale** and fractionalising overheads and other fixed costs
2 Improve value	Manufacturers can increase their competitiveness by improving their value proposition to customers. For example: – Manufacturers can focus on **innovation and technological improvements** that give their products a distinctive performance value proposition – Manufacturers can increase the value of their products by providing **value-adding services** that improve their function, utility and longevity
3 Shift market focus	Manufacturers can increase their competitiveness by moving into higher-potential products and markets in which their proposition is more distinctive. For example: – Manufacturers can identify and enter **high-growth or high-value product segments** – Manufacturers can identify and enter **under-served geographies** and participate in **global value chains**

AMGC is committed to deepen and enhance the understanding of Australia's manufacturing competitiveness. Its research, using latest available company data, finds that the most successful manufacturing firms – in Australia and globally – share three common features:

- **Advanced knowledge:** successful manufacturers tend to be innovation leaders. They spend more on R&D and foster research collaborations, have larger patent portfolios, and hire highly-skilled employees.
- **Advanced processes:** successful manufacturers make smarter use of technology than their peers. They embrace automation, have efficient energy and water systems in place, and invest in state-of-the-art equipment.
- **Advanced business models:** successful manufacturers tend to lift the value of their products by acting as niche market players or service champions. They seize opportunities to export and supply to larger firms globally. They also broaden their businesses to include more services.

1.5 IMPROVING AUSTRALIA'S MANUFACTURING RESILIENCE

In addition to striving for competitiveness, Australian manufacturers must set themselves up to be resilient through periods of volatility. AMGC's report, *Building Resilience in Australian Manufacturing*, shows that Australia is home to one of the most volatile manufacturing industries in the developed world.[5] This is why AMGC also seeks to embed a new mindset of resilience within Australian manufacturing.

Resilient firms can be defined as those that outperform their industries during periods of volatility by displaying higher than average earnings. This means that when revenues and profits slump, they survive, adapt and grow more quickly (or contract more slowly) than their industry peers. Embedding a mindset of resilience will help Australia manufacturers succeed in good times and bad and position the industry as an ongoing source of innovation and prosperity in the economy. Just as every manufacturer can be advanced, every firm has the ability to succeed through downturns if it identifies the source of volatility it is facing and adopts a corresponding resilience strategy. AMGC's analysis indicates that Australia's most resilient manufacturers typically sell high-value products that are superior to those of rivals and command a higher price. They are highly diversified, cushioning their vulnerability to market fluctuations. They have also implemented business structures that allow them to move flexibly during challenging times.

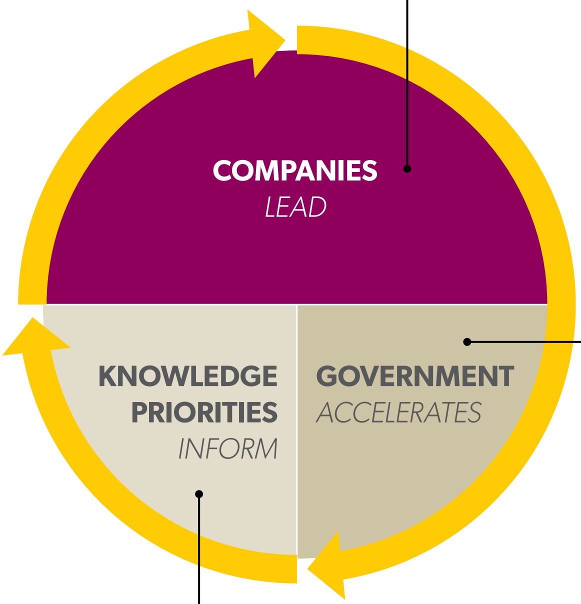
5 AMGC, *Advanced Manufacturing: Building resilience in Australian Manufacturing*, 2018. Publication updating.

1.6 ACTION PLAN FOR AUSTRALIAN MANUFACTURING

AMGC's vision is to develop an internationally competitive, dynamic and thriving Australian manufacturing industry that boosts the long-term health of the economy and the nation. Achieving this vision will require a national effort from stakeholders across industry, government and research. Above all, it is vital that the transition be led by companies (see Exhibit 4). This Manufacturing Competitiveness Plan identifies key actions for industry to embrace transformation, supported by government policies and programs, and nationally-set Knowledge Priorities.

Exhibit 4 – Companies must lead the transition to competing on value, supported by government and informed by Knowledge Priorities

Objective: Australian manufacturers need to compete through product and service differentiation, and better target export markets



Companies will lead the transition by:

- Increasing technical leadership
- Increasing value-adding services
- Improving market focus by reaching untapped markets and integrating into global value chains
- Lifting scale and management quality.

Many Australian businesses are already making this transition.

Government can accelerate the transition to new value-based business models by:

- Optimising support for business-led R&D
- Using smarter defence and civil procurement
- Designing assistance to target 'more advanced' characteristics
- Changing measurement of manufacturing.

Knowledge Priorities will inform and fuel the transition by:

- Identifying R&D Priorities: e.g. robotics, advanced materials and composites, digital design and rapid prototyping
- Identifying Business Improvement Priorities: e.g. workforce skills requirements, management capability, building international linkages and driving digitalisation
- Identifying national areas of strength and focus (e.g. National Manufaturing priorities).

Source: Competitiveness analysis

1 EXECUTIVE SUMMARY

Actions for industry

Australia has many world-class manufacturing companies. It is now time for the industry to consolidate this existing capability by embracing industry-led transformation focused around four objectives:

- **Enhance value differentiation by increasing the technical leadership of Australian manufacturing.** The single biggest opportunity for Australian manufacturing is to increase its technical leadership and improve the distinctive value of its finished or intermediate products. Firms should focus on lifting their technical leadership in three ways. Firstly, by increasing expenditure on R&D, which is a core enabler of value differentiation. Secondly, by strengthening their collaboration with research institutions (of particular importance for small manufacturers which exhibit the lowest levels of collaboration). Seeking out project-specific partnerships, sharing personnel and co-investing resources can all help Australian companies develop their ideas and technical leadership. Thirdly, firms should seek to exploit Australia's cost advantage in high-skilled labour by lifting the skill mix of their workforce.
- **Enhance value differentiation by increasing service offerings within Australian manufacturing.** Australia has a significant opportunity to complement its manufactured products with value-adding services that open fresh revenue streams and improve the value differentiation of our products. With a highly skilled, English-speaking workforce, Australian manufacturers are well placed to develop service-enhanced offerings. Notably, sub-industries that have already made this shift are growing faster than those that still focused on the production parts of the value chain. To achieve this, Australian manufacturers will need to develop compelling service offerings, identify and build new markets and shift the mix of their workforce towards service skills.
- **Improve market focus by reaching untapped markets and segments, and integrating into global value chains.** Australian manufacturers should not only focus on improving the cost and value of what they produce today; they must also identify new markets and product segments. There is a significant opportunity for firms to grow by identifying niche products or service markets, or under-served export markets. Australian manufacturers are underweight in a number of key export markets, including for intermediate goods. They are poorly linked into global value chains.
- **Improve resilience to ensure long term performance.** Even successful manufacturing companies can lose their advantage when their industry enters a period of contraction or if customer tastes change. To achieve greater resilience, Australian manufacturers need to focus on one or more of the following strategies: building their superiority through R&D collaboration and investment; building diversification by expanding into new export markets and customer segments; and building flexibility in production and workforce utilisation.

Actions for governments

While companies must be the lead players, governments can play a significant role in supporting the actions that companies need to undertake in order to accelerate transformation. Taken together, these policy changes amount to a fundamental shift in the focus, balance and operation of government support, to help ensure that Australia's manufacturing industry is able to thrive in the future:

- **Improve government support for business-led R&D and encourage research–industry collaboration:** Support for R&D and research collaboration have underpinned Australia's capability and export successes, particularly in sub-industries such as medical technology. If more companies are to experience similar success, governments should improve and better target the R&D Tax Incentive to increase support for innovation activity in desired verticals that would have not otherwise happened (in other words, to increase 'additionality'). They should also boost support for both medium-risk, short-term R&D through the Tax Incentive, and higher-risk, longer-term R&D through more direct forms of grant assistance and impact monitoring. This may require eligibility criteria to be tightened. The savings could then be used to both simplify application processes, driving additional take-up, and to shift the mix of support towards more 'direct' and 'directed' forms of grant assistance. Stronger collaboration between companies and universities will ensure Australia's strong research pipeline is better translated into commercial outcomes.

- **Use smarter procurement and programs to drive advancement:** Federal and state governments have the opportunity to leverage procurement to drive innovation and collaboration between firms, and to create opportunities for Australian manufacturers in global supply chains. Government procurement usually is shortsighted but could instead boost technical leadership, ideally in areas where Australian manufacturing has a current or potential future comparative advantage. These parts of the economy could then be developed to scale through guaranteed demand. It is vital that support is not provided to prop up industries that were once semi-competitive but are no longer viable. Innovation requirements should be established so that the technology or product will be a globally distinctive offering. Other industry assistance and capability-building programs offered by federal and state governments could also be better designed to target the characteristics associated with manufacturing advancement in focus areas.
- **Change how manufacturing is perceived and measured in the economy:** Governments and the public must recognise that manufacturing is not a sector and about more than simply production. A dynamic manufacturing industry might include more services and less local production output where not viable. Rather than measure the manufacturing industry narrowly through production output in a set of Australian and New Zealand Standard Industrial Classification (ANZSIC) codes, new metrics are needed to establish whether manufacturing is advancing and identify its wider impact on the economy. This includes tracking whether the prevalence of key characteristics is increasing, as well as the indirect employment impact of manufacturing.
- **Improve existing programs that support resilience** by expanding business advisor expertise, better targeting funding, and increasing proactive connections between firms and R&D institutions and multinational corporations. Australia is well advised to study and copy success factors of internationally proven success stories such as Fraunhofer Society and UK Catapults.

Knowledge priorities

The industry-led transformation of Australian manufacturing should be supported by urgent investigation of the following knowledge gaps in R&D and business capabilities that have been identified by the industry. These Knowledge Priorities were developed by AMGC following a comprehensive competitiveness analysis, literature review and industry consultation, including a survey of more than 50 industry respondents.

- **R&D priorities:** The industry has identified detailed knowledge gaps in the fields of robotics and automated production processes; advanced materials and composites; digital design and rapid prototyping; sustainable manufacturing and life cycle engineering; additive manufacturing; sensors and data analysis; materials resilience and repair; bio-manufacturing and biological integration; nano-manufacturing, micro-manufacturing and precision manufacturing; and augmented or virtual reality systems.
- **Business improvement priorities:** The industry has identified detailed knowledge gaps about business capabilities in the areas of drivers of the management capability gap; understanding current and future workforce skills requirements; building better international linkages; driving digitalisation uptake; and leveraging government procurement.

Digitalisation and Industry 4.0

'Industry 4.0' refers to the suite of digital technologies augmenting industrial processes, including

1) the rise of data volumes, computational power and connectivity

2) emergence of business-intelligence capabilities

3) new forms of human-machine interactions

4) improvements in transferring digital instructions to the physical world, e.g. 3D printing'

1.7 ROLE OF AMGC AND NEXT STEPS

The role of AMGC is to harness its unique capacity as an industry-led but government-supported body to help transform Australian manufacturing. There are three key ways that AMGC is delivering on this promise:

- **DIRECTION** AMGC will set a direction to transform manufacturing in Australia through its Manufacturing Competitiveness Plan, additional research publications, and materials on Knowledge Priorities. AMGC continues to test industry Knowledge Priorities and barriers to competitiveness. It will apply the knowledge and insights that it gains within major initiatives, such as its online learning tool Manufacturing Academy, with Australian manufacturers. AMGC will also release its research into Manufacturing Workforce Skills.
- **DEMONSTRATION** AMGC will demonstrate ways to achieve this direction through transforming industry projects that help increase the industry's competitiveness. Since its inception, AMGC has facilitated over 115 projects across Australia, with over $135.05 million in AMGC and in-kind funding. These projects are expected to deliver over 4,000 new jobs and an additional $1.52 billion in revenue. They serve as demonstrations of best practice to transform manufacturing in Australia and pave the way for other firms and research institutions. AMGC will continue to co-fund projects through the Commercialisation Fund and Northern Territory Advanced Manufacturing Ecosystem (AME) Fund that implement the identified priorities for the industry.
- **AWARENESS** AMGC will aim to increase the awareness of manufacturing companies surrounding value-driven best practices by promoting evidence-based messages through AMGC events, media relations, COVID-19 Manufacturer Response Register, and other communication channels. Further communication methods that focus on inspiring manufacturing companies about the benefits of competing on value through the identified best practices can reinforce a company's perception surrounding the transformation encouraging the companies to take steps for more information. AMGC's online learning tool – the Manufacturing Academy – will continue to be updated to reflect major advancements within the industry, such as its recent expansion that saw the launch of a seven-part learning module titled 'Manufacturing with Rosie'. This new module provides an overview of manufacturing opportunities in Australia, details the six National Manufacturing Priorities and demonstrates gender diversity.
- **IMPACT** To pursue industry-wide impact, AMGC will seek to influence the strategies pursued by companies and governments. Companies require a comprehensive understanding of the requirements to shift towards more manufacturing capability. Over the next 12 months, AMGC will continue to work with its members and the broader manufacturing network to ensure that all stakeholders have access to this body of knowledge and can derive more tailored insights. This includes, but is not limited to, continuing to provide co-funding and management resources to support projects that help promote the industry's export competitiveness. AMGC will also work with relevant departments to improve government support for business-led R&D; inform procurement officers about key levers of competitiveness; ensure a strong industry-policy role in upcoming defence procurement; ensure evaluation criteria for relevant assistance are aligned with advanced characteristics; ensure programs that offer capability-building target the development of advanced characteristics; and modify how manufacturing is measured.

As COVID-19 plays out during the 2021–2022 financial year, AMGC will continue to support Australian manufacturers responding to the rapidly evolving business environment by adapting projects' deadlines, activities, and services as required. AMGC will continue to seek opportunities to support Australia's manufacturing industry as the country emerges from the main thrust of the pandemic and work toward new opportunities.

AMGC will work with companies, governments and other stakeholders to implement this Manufacturing Competitiveness Plan and harness the true potential of Australian manufacturing. This will benefit both the manufacturing industry and the wider economy. Manufacturing capability is critical to Australia's future.

> Over the next 12 months, AMGC will continue to work with its members and the broader manufacturing network to ensure that all stakeholders have access to this body of knowledge and can derive more tailored insights.

> The importance of skill mix suggests that a shift towards higher-skill composition or skill-intense production will be important if Australian manufacturers are to be more competitive in the future.

2 THE TRANSFORMATION OF MANUFACTURING

2 THE TRANSFORMATION OF MANUFACTURING

> Manufacturing can be a force for growth in this country. We have gotten complacent in thinking about it as an old-fashioned industry of the past, but it is becoming obvious globally that advanced countries are fighting to become competitive in this industry.

Industry participant, AMGC consultation[6]

2.1 OVERVIEW

Manufacturing is undergoing a historic transformation across the industrialised world. As traditional assembly line production activities are either automated or outsourced to developing countries, it is becoming less common for firms to mass-produce identical factory lines of finished goods. Instead, manufacturing today increasingly involves the precise tailoring of components, services and solutions within complex and global supply chains. Importantly, as shown in the so-called 'smiley curve' (see Exhibit 2 on page 10), manufacturers are diversifying so they can add value at different stages of the manufacturing process – both before and after goods are produced. Work practices are also changing. Digital transformation of the manufacturing process is ushering in exciting techniques such as 3D printing, where physical objects are created from virtual templates. Connected 'smart factory' environments allow customer feedback to loop back and inform product development in real time.

Part of AMGC's mission is to provide an authoritative understanding of the rapidly evolving nature of manufacturing in Australia. In this section, AMGC also seeks to clarify what it means to be a manufacturer. This will help governments and the public better recognise the role of manufacturing capability in Australia's economy and its contribution to advancement. It will also form a credible basis for ongoing policy, regulatory and funding decisions. Given its strong commitment to industry-led transformation, AMGC is keen to guide local manufacturers that are looking to reinvent themselves and seize new opportunities beyond the production line. This is by no means an exclusive category. Every single manufacturer in Australia has the potential to advance capability.[7]

6 This comment was recorded during AMGC's consultation with industry members. It was made by the representative of a regional industry association.

7 Further details can be found in AMGC's recent report "Advanced Manufacturing. A new definition for a new era", published in late 2017. Available at: https://www.amgc.org.au/advanced-manufacturing-new-definition

2.2 TOWARDS A NEW DEFINITION

'Advanced manufacturing' is currently defined by the Australian Government as "any manufacturing process that takes advantage of high-technology or knowledge-intensive inputs as an integral part of its manufacturing process". The Government further stipulates that 'advanced manufacturing' includes chemical and medicinal manufacturing, as well as vehicle and transport, professional and scientific equipment, computer and electronic, and specialised machinery and equipment manufacturing.

However, AMGC's analysis, published in 2017, of more than 3,000 global manufacturing companies has found conclusively that belonging to a certain sub-industry, whether or not this industry is officially classified as 'advanced', says little about a company's ability to compete and remain profitable in an increasingly challenging market environment. For example, AMGC's research into what constitutes a 'successful' company shows that only 4% of global manufacturing companies in the electrical equipment sub-industry would be considered highly competitive, even though many people might associate this industry with high-tech products and think of it as 'advanced' (see Exhibit 5 on page 22). By contrast, 13% of companies involved in textile milling and 10% of apparel manufacturers rank highly on this metric of success, even though both sub-industries are not among the few considered to be 'advanced' by the Australian Bureau of Statistics (ABS).

Informed by this research, AMGC considers that it is time to update and expand the definition of what it means to be an 'advanced' manufacturer. Above all, it is imperative to move beyond a focus on particular sub-industries or production output. Accordingly, AMGC defines 'advanced manufacturing' as the application of leading-edge technical capability for the creation of products, production processes and associated services for the purpose of sustaining high growth and customer satisfaction.

This new, broader definition focuses on the sophistication of businesses, rather than on the products they make. It acknowledges that there is no hard line separating advanced manufacturers from others. Instead, it is possible to employ advanced techniques in furniture manufacturing, just as it is in aircraft engineering. Degrees of advancement can occur in every sub-industry. In fact, it is helpful to think of all companies moving along a continuum from less to more advanced as they employ a range of techniques and strategies adapted to their circumstances. As noted above, every Australian manufacturer, big or small, high-tech or lower-tech, can advance. It is not about *what* a company makes, but *how*.

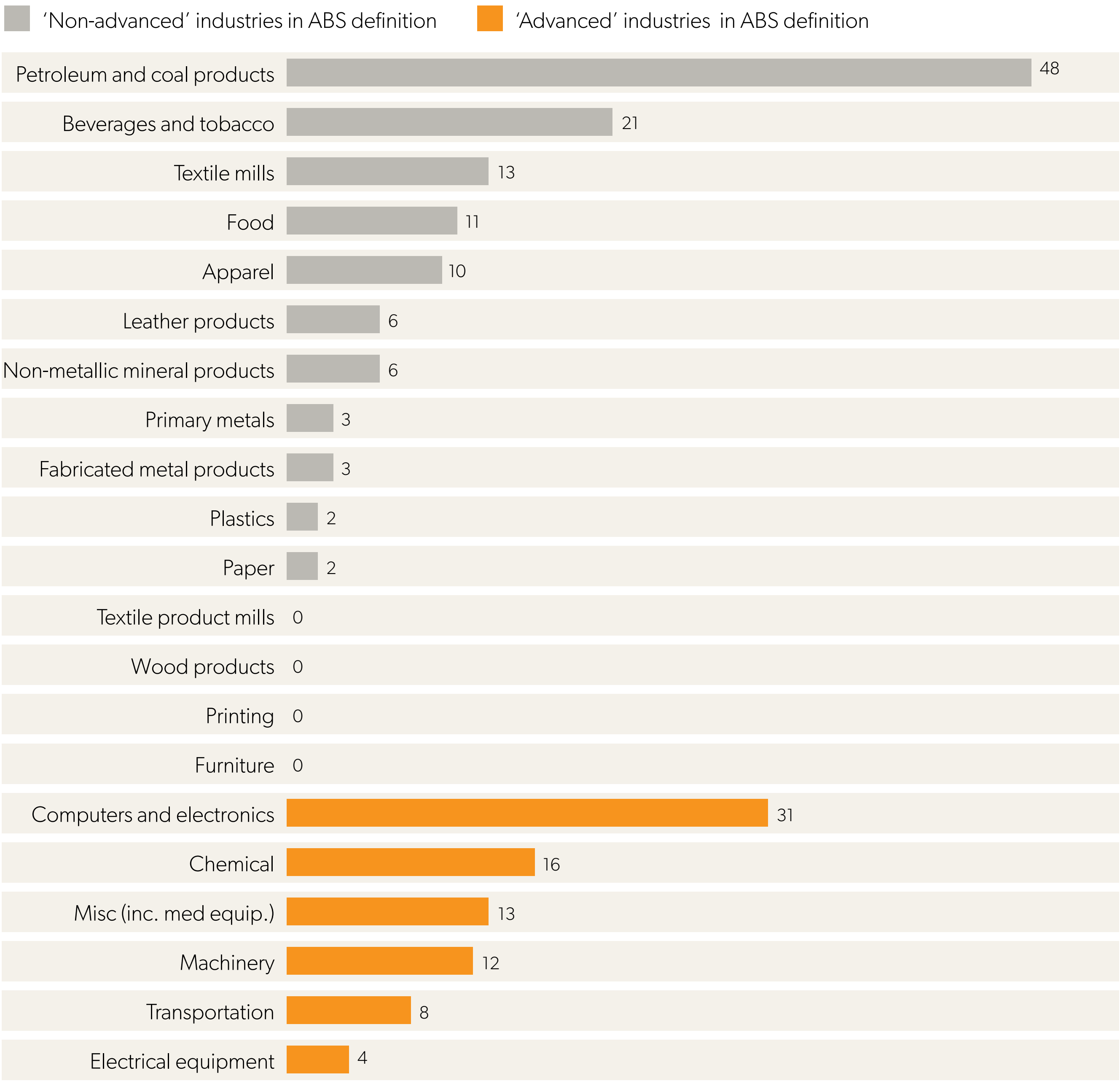
Advancement is not static. The 'advanced manufacturer' of today will be, without advancement, the traditional manufacturer of tomorrow.

National Manufacturing Priorities

- **Resources Technology & Critical Minerals Processing**
- **Food & Beverage**
- **Medical Products**
- **Recycling & Clean Energy**
- **Defence**
- **Space**

Exhibit 5 – Every Australian manufacturer has the potential to advance

Our analysis shows successful manufacturers in almost every manufacturing sub-industry
Share of most successful firms per sub industry,* in %



2.3 CHARACTERISTICS OF SUCCESSFUL MANUFACTURERS

With the aim of further guiding Australian firms to achieve manufacturing advancement, AMGC has identified that the most successful global and Australian firms share a range of business characteristics. Based on analysis of the latest Compustat and ABS Business Longitudinal Analysis Data Environment (BLADE) business survey data, these characteristics broadly fit into three categories: advanced knowledge, advanced processes and advanced business models.

- **ADVANCED KNOWLEDGE:** successful manufacturers tend to be innovation leaders, scoring highly on measures such as R&D spending, information and communication technology (ICT) intensity, patent portfolio size, employee qualifications and research collaboration.

Business characteristics of companies with advanced knowledge

- Higher spending on R&D
- Higher information and communication technology (ICT) intensity
- Larger patent portfolio
- More collaboration with research institutions
- More collaboration with other manufacturers
- Higher relative salaries and wages
- Better qualified employees
- More staff with math, engineering, science and technology (MEST) skills

- **ADVANCED PROCESSES:** many successful manufacturers are also process winners who make smarter use of technology, scoring highly on measures such as capital intensity, use of automation, energy and water efficiency, and having newer equipment.

Business characteristics of companies with advanced processes

- Greater capital intensity
- Newer equipment
- More automation
- Smarter inventory management
- Better energy efficiency
- Better water efficiency

- **ADVANCED BUSINESS MODELS:** finally, successful manufacturers tend to lift the value of their products by acting as niche market players or service champions, scoring highly on measures such as trade intensity, linkages with other firms and greater share of services in total revenue.

Business characteristics of companies with advanced business models

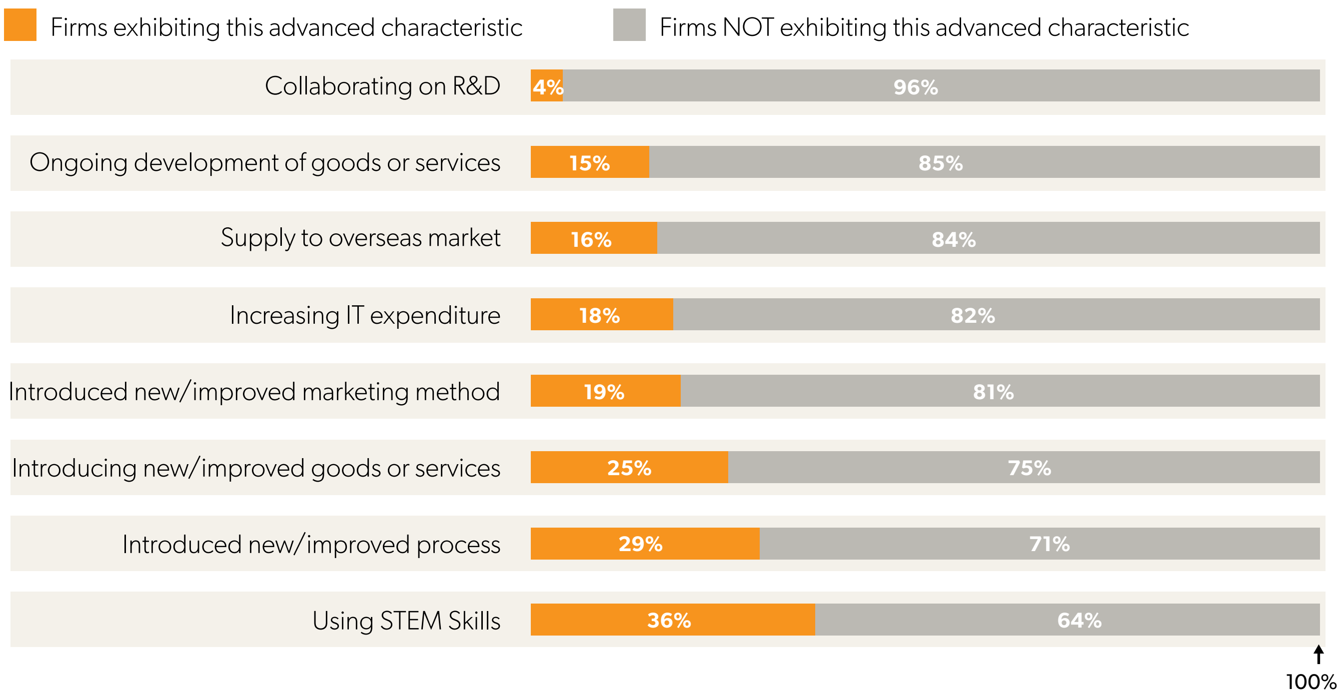
- Higher product value density (by weight)
- Higher marketing expenditure
- Higher trade intensity
- More extensive backward links
- Larger geographical reach
- Greater share of services in total revenue

Even as Australian manufacturing continues to make progress, it is worth noting that the number of firms who could be operating as competitive manufacturers today remains small. The overwhelming majority could still do more to develop the advanced characteristics that AMGC's research shows to be vital for success. For example, 96% of Australian manufacturing firms have so far failed to develop solid R&D collaborations, while a further 84% of firms have yet to develop an export strategy and supply their products to overseas markets (see Exhibit 6).

Exhibit 6 – There is significant room for Australian manufacturers to increase their adoption of advanced techniques

Most Australian manufacturing companies are not engaged in advanced processes and techniques

Weighted average fraction across 2009–13 and 2010–14 panel, in %



2.4 ACCURATELY MEASURING MANUFACTURING ACTIVITY

A key benefit of moving to a more contemporary understanding of manufacturing is being able to include workers across the entire value chain, not just those employed in production activities. This enables a more accurate depiction of the industry's size and economic contribution.

According to official ABS labour market data as of May 2017, Australian manufacturing directly employs 912,500 people in industries involving production such as aerospace parts, furniture and food. However, as noted in Section 2.1, the trends for companies to specialise within global value chains and outsource non-core functions means that many workers are focused on areas such as research and development (R&D), design and logistics, sales and services. These are people who might have once been directly employed by manufacturers and are now employed in supporting companies. For example, some manufacturers outsource cleaning work to building management companies, while others hire visual designers to create virtual diagrams of product prototypes.

These additional workers, who represent an estimated 360,000 people together representing almost 10% of the total manufacturing workforce, are critical to the Australian manufacturing industry. Adding them to the ABS count of 905,000 manufacturing employees, it is more accurate to state that the Australian manufacturing industry employs 1.27 million directly and indirectly (see Exhibit 7).

Overall, AMGC's analysis shows that 47%, or almost half of Australia's manufacturing workforce, is employed in jobs related to R&D, design, logistics, and sales and service functions, as opposed to core production roles. This can be broken down further as follows:

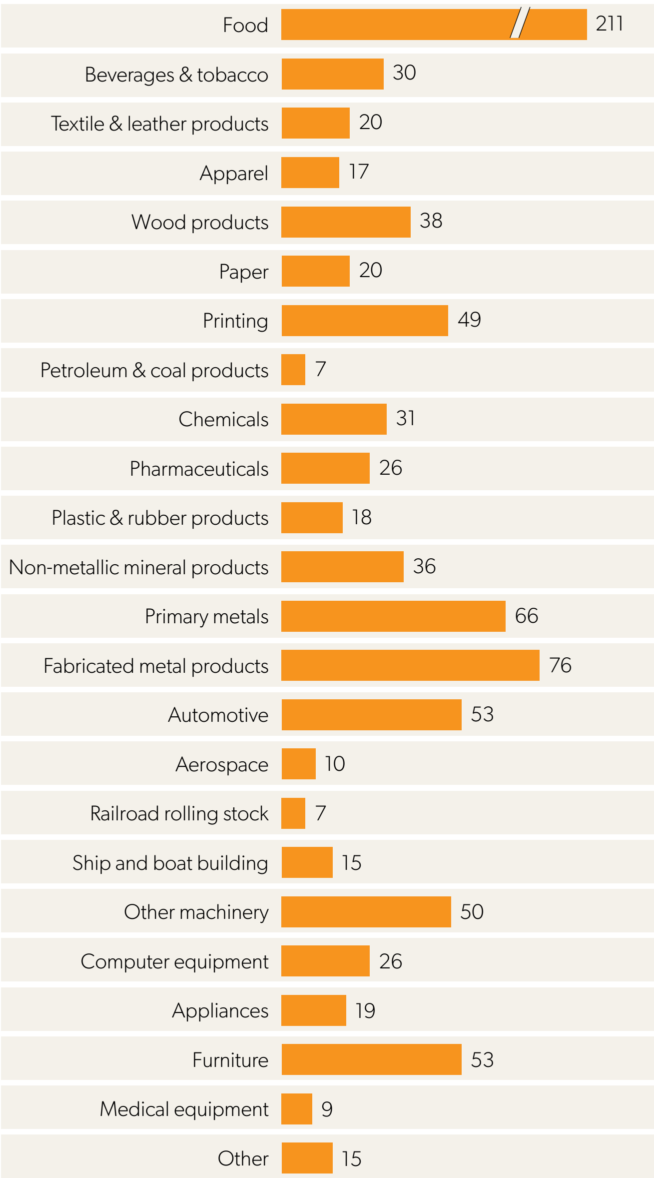
- R&D and design-related occupations such as materials engineers, chemists, graphic and product designers, and lab assistants, account for 13% of jobs in manufacturing. These are the employees who help identify what new products to make and how to make them.
- Logistics occupations such as purchasing managers, crane operators and packagers, account for 18% of the workforce and help connect the industry with its markets and global supply chains.
- Sales and service occupations such as telemarketers, customer service assistants, sales managers and product trainers, account for 16% of the workforce. These people find markets for their employers' goods and incorporate client feedback into the design and product development process.

It quickly becomes clear that manufacturing involves many more roles than those undertaken by workers and machines on the factory floor.

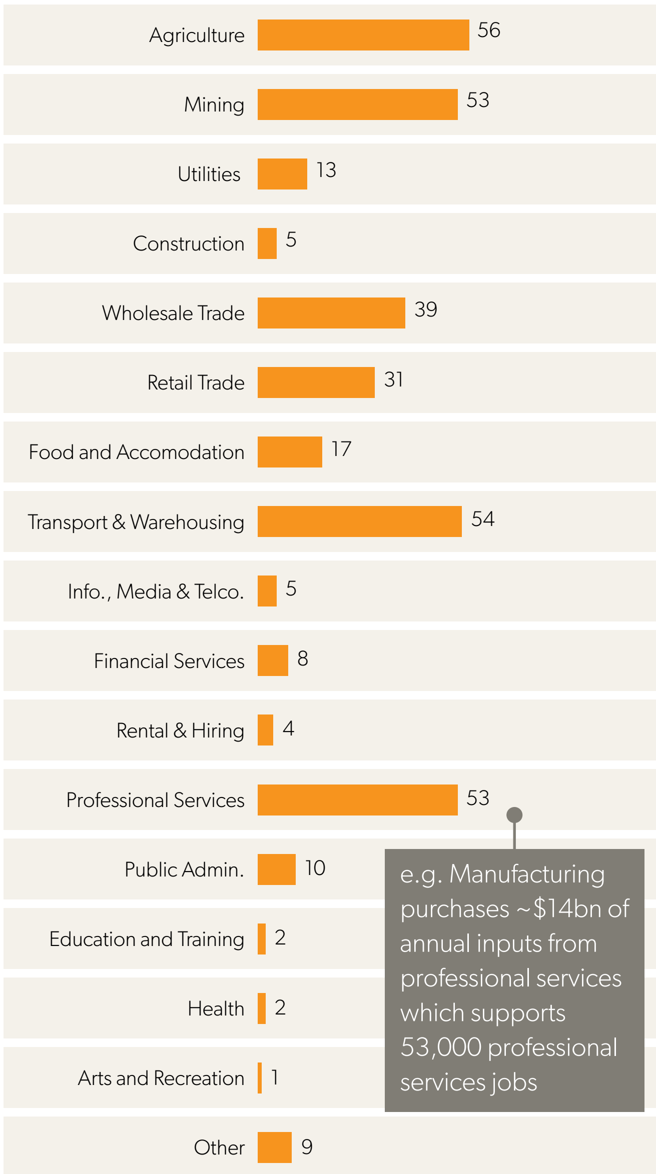
"The Australian manufacturing industry employs 1.27 million directly and indirectly. It quickly becomes clear that manufacturing involves many more roles than those undertaken by workers and machines on the factory floor.

Exhibit 7 – Manufacturing wholly supports ~ 1.27 million jobs in Australia; of which 30% are outside manufacturing in industries providing direct inputs

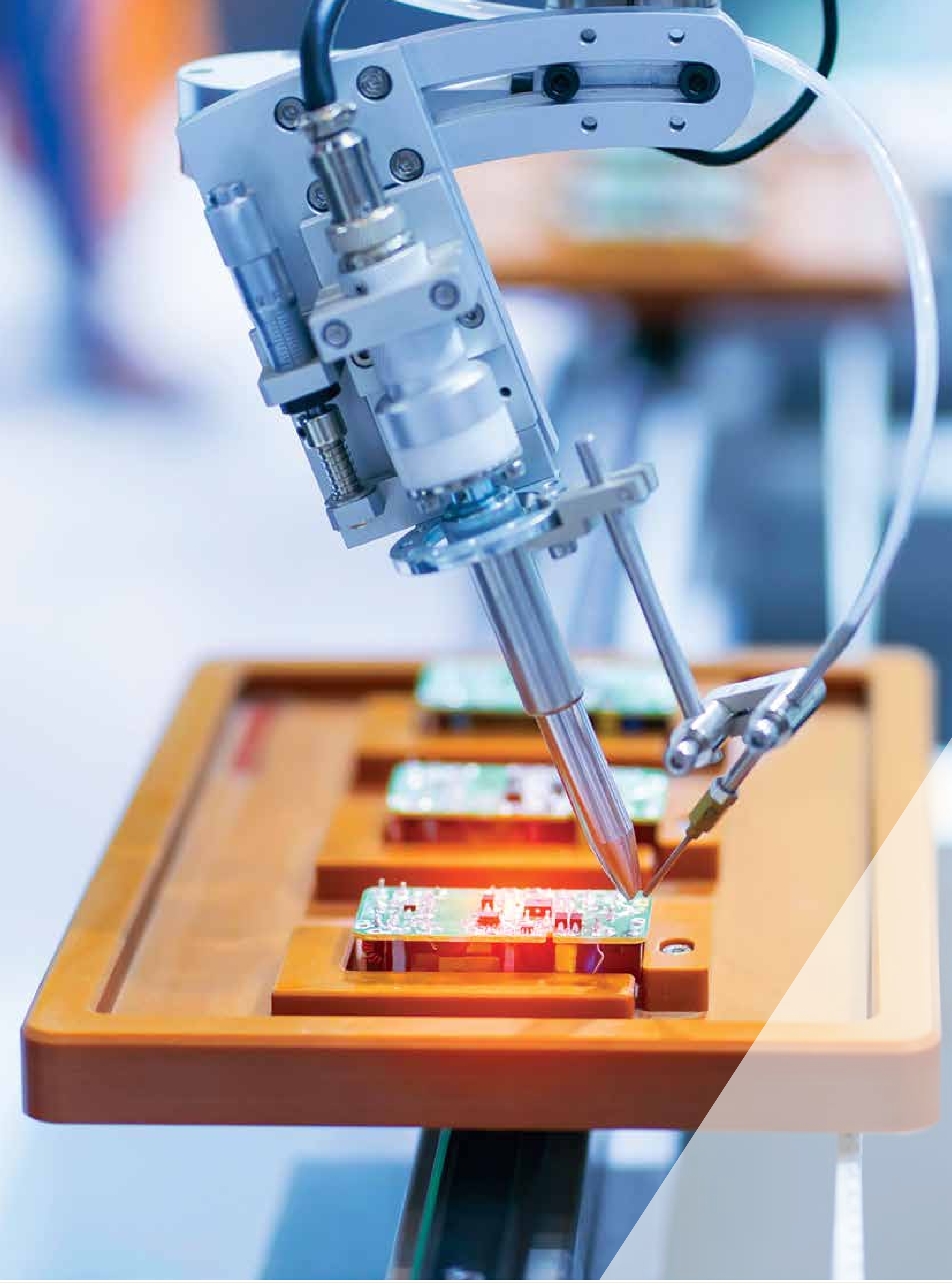
Manufacturing directly employs 905,000 workers in manufacturing classified sub-industries
Number of workers employed within manufacturing industries ('000)



Manufacturing indirectly supports 360,000 workers outside manufacturing
Number of workers employed providing direct inputs to manufacturing ('000)



Note: Indirect employment was calculated using input–output tables and the average labour productivity of each industry.
Source: ABS and analysis conducted by AlphaBeta Advisors. May 2017



> Manufacturing capability offers enormous opportunities for Australia. However, realising this potential will necessitate major changes in mindset.

3 BALANCING COMPETITIVENESS AND RESILIENCE

3 BALANCING COMPETITIVENESS AND RESILIENCE

3.1 OVERVIEW

AMGC is committed to Australia's future manufacturing success based on fostering greater competitiveness and resilience within the industry. Manufacturing offers enormous opportunities for Australia. However, realising the potential will necessitate major changes in mindset.

This Manufacturing Competitiveness Plan is based on extensive consultation with industry stakeholders and detailed empirical analysis, focused initially on the two sub-industries of aerospace and medical technology. Above all, it challenges the conventional wisdom that driving down production costs is a primary driver of Australia's manufacturing competitiveness.

Instead, AMGC calculates that improvements in 'value differentiation' create the largest economic benefits: an estimated increase of up to 20% in value added by 2026. For Australian manufacturers, this means that delivering a truly unique solution – one that incorporates innovative design or technology, an outstanding service offer or an exceptional reputation for reliability – will often be more advantageous than undercutting competitors on cost. This is particularly true given that AMGC's research reveals that 58% of Australians are happy to pay more for products made in Australia, because they believe they will be high quality. In addition, most Australians (80%) think it is important to buy products that are Australian made, where possible.

At the same time, AMGC believes that Australian manufacturers need to deploy forward-thinking strategies that boost their resilience as well as their competitiveness. This will help them survive economic downturns and ensure their longer-term performance.

Why aerospace and medical technology?

The Australian manufacturing industry comprises numerous sub-industries that exhibit individual characteristics and respond differently to challenges and opportunities. To narrow its focus, AMGC made the decision to initially focus on two specific sub-industries: aerospace and medical technology. These sub-industries were carefully selected to serve as benchmarks when analysing the impact of strategies to improve the competitiveness of Australian manufacturing overall. This was done for two reasons. Firstly, aerospace and medical technology are often considered more advanced, successful and export-oriented and are thought to generally offer lessons for other manufacturers on how to increase their competitiveness. Secondly, both sub-industries are diverse in their industry structures, innovation models and barriers to success, which allows for a breadth in results. Not surprisingly, both of these sub-industries were pinpointed by the Australian Government as part of the six National Manufacturing Priorities under the Modern Manufacturing Strategy.

3.2 A NEW COMPETITIVENESS FRAMEWORK

Cross-country studies of manufacturing capability tend to focus on cost as the main driver of competitiveness. While undoubtedly important, cost is far from the only dimension of competitiveness, especially for Australian manufacturers with export ambitions. Australian products normally succeed in global markets because they offer something different – perhaps innovative features, or an exceptional reputation for reliability, or an outstanding after-sales service proposition. The reality of Australia's high-wage economy and distance from global markets is that its manufacturers often succeed by being better, not just cheaper, than their competitors.

With this in mind, AMGC has developed a new competitiveness framework for the purposes of this Manufacturing Competitiveness Plan (see Exhibit 8).[8] As described below, it distinguishes between three strategies to improve a manufacturer's competitiveness:

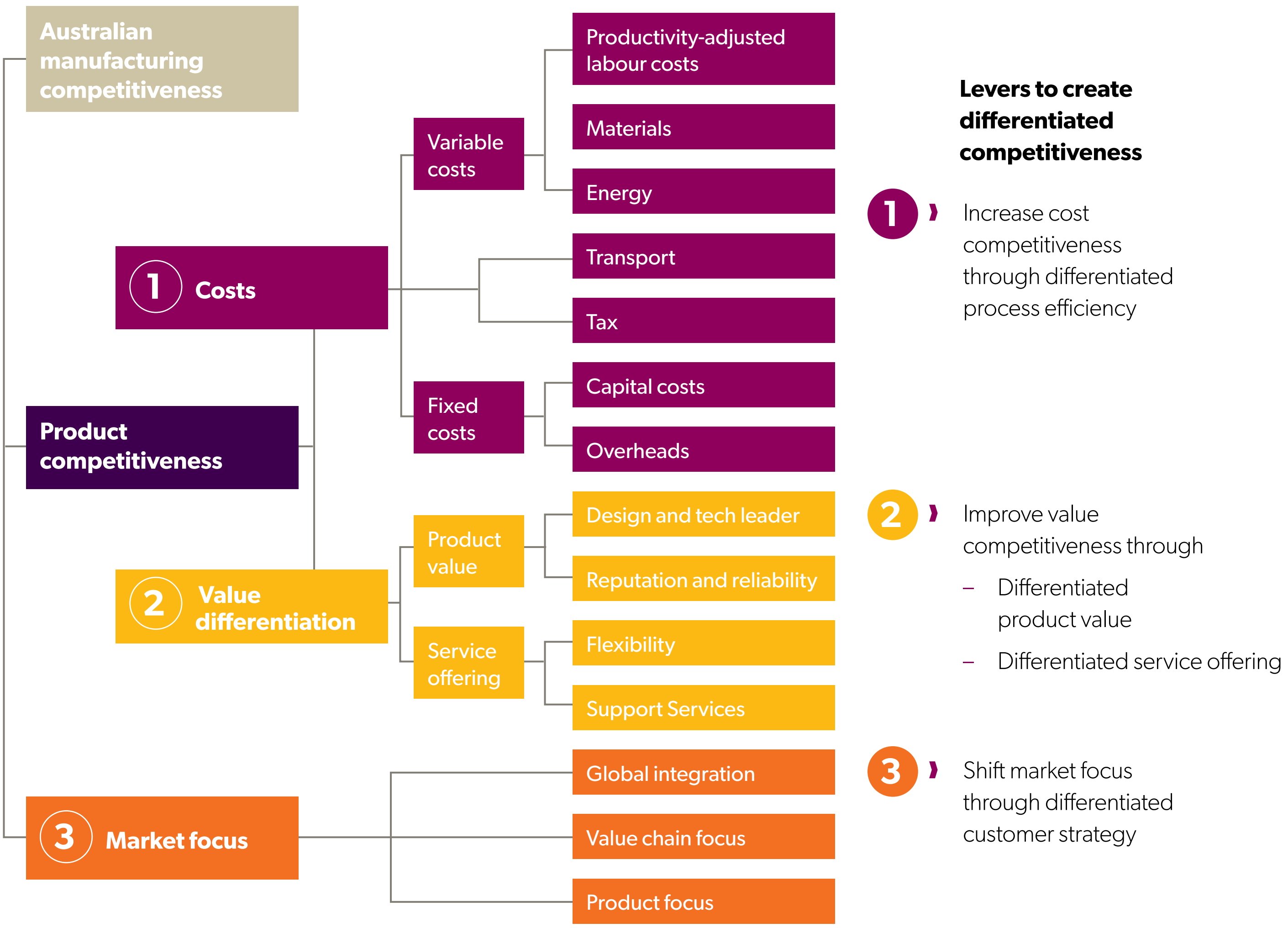
- **Product cost:** The composition of costs that drive the final price of a produced good, including variable costs (such as labour, materials, energy and transport), tax and fixed costs (such as capital and overheads).
- **Value differentiation:** The sources of value creation for customers beyond product cost, such as product leadership, reputation and reliability, flexibility and service offering. Hard-to-replicate sources of differentiation (such as world-leading technology protected by patents, or a reputation for unrivalled quality or reliability) can create a source of competitive advantage, resulting in larger and more sustainable margins than those that can be achieved by manufacturers who compete on production cost alone.
- **Market focus:** The ability of manufacturers to boost their competitiveness by changing where they 'play'. This includes whether they serve growing customer segments or markets, and whether they are focused on skill-intensive product niches. Shifting to the highest potential markets that play to Australian manufacturing's strengths can significantly increase value and the nation's overall competitiveness.

> Australian products normally succeed in global markets because they offer something different.

8 The framework uses information from an international panel of manufacturing purchasing managers and customers. It was developed using proprietary research and an analysis of the success characteristics of more than 3,000 global firms, based on Standard & Poor's (2016), Compustat Database (accessed: August 2016).

Exhibit 8 – We better understand ways Australian manufacturers can boost competitiveness by thinking more broadly than cost, looking also to 'value' and 'market focus'

Competitiveness framework



Source: Based on >25 interviews with final customers/international purchasing managers about what matters most and analysis of successful characteristics of 3,040 global manufacturing firms. AlphaBeta/McKinsey analysis

3.3 THE 'SIZE OF THE PRIZE'

AMGC's research reveals that there is no single formula or 'one-size-fits-all' approach to manufacturing success. Australia's most profitable and competitive manufacturing firms use a range of strategies to differentiate themselves from their peers. For example, they might lower costs by using energy more efficiently; lift their reputation by offering high-value and customised niche products; and improve their market focus by tapping into global value chains.

These strategies are not mutually exclusive. An individual firm could pursue just one or a combination of them to succeed. Regardless, the rewards for success in advancing manufacturing are substantial. The size of Australia's manufacturing industry in the year to June 2017, in gross value added or output terms, was $108 billion or 5.6 per cent of GDP.[9] AMGC's modelling suggests that the output of Australia's manufacturing industry as a whole could increase 25–35% by 2026 (see Exhibit 9).[10] More than half of this gain (14–20%) could come from companies sharpening their value differentiation strategies.[11] A stronger market focus in Australian manufacturing could lift the industry's output by 7–9%.[12] Improvements in cost competitiveness could drive 4–6% of the estimated 'size of the prize'.[13]

9 ABS, Australian System of National Accounts, Gross Value Added by Industry, cat. no. 5204.0, October 2017. Available at: http://www.abs.gov.au/ausstats/abs@.nsf/mf/5204.0

10 The base case size of manufacturing in 2026 uses the 2006–14 CAGR as the average annual growth rate through to 2026.

11 The estimated increase in industry output through value differentiation was calculated as an average of multiple methods: lifting performance in export categories in select manufacturing sub-industries analysed in the Plan to either the highest or the average level of revealed comparative advantage; closing the gap between the profitability of a sample of successful firms and the average; and increasing the proportion of high-skill workers in select sub-industries to US levels. This is consistent with previous studies that have identified innovation as the key source of competitive advantage for Australian manufacturers. See, for example, Green, R. & Roos, G. (2012), Australia's Manufacturing Future: Discussion paper prepared for the Prime Minister's Manufacturing Taskforce, Sydney. Available at: https://www.uts.edu.au/sites/default/files/Australia%27s_Manufacturing_Future.pdf

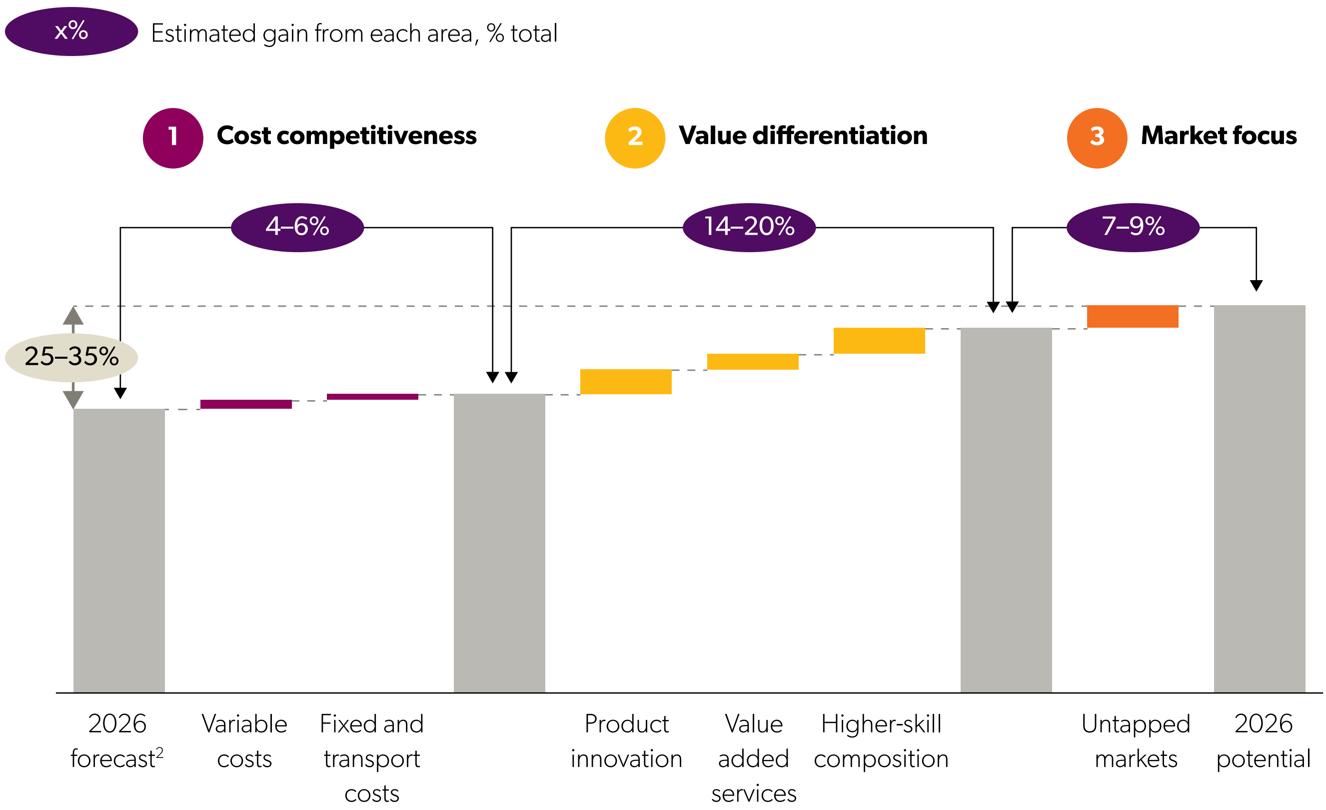
12 The estimated increase through market focus involves closing the gap in select sub-industries in export markets where Australia is underweight relative to Australia's average share for that product category and shifting product mix to more skill-intense sub-industries, where Australia is underweight relative to the US.

13 The estimated increase through product cost was calculated by closing the labour productivity gap for select sub-industries and applying these across the manufacturing industry, and banking the savings alternatively as profit or in the form of a price decrease to customers, with varying elasticities. The annex provides an expanded and detailed methodology on how we estimated the size of the opportunity.

Exhibit 9 – Growth in manufacturing can be achieved by focusing on greater value differentiation and improved market focus, not cost alone

Estimated potential value gain across advanced manufacturing

Percentage of value added in 2026 relative to straight-line trend projection[1]



Notes

- Benchmarking 'landed' product cost against other high-cost countries revealed a 9–14% cost gap
- Improvement estimates based on different scenarios of closing the cost gap and either banking savings as profit or passing through lower prices
- Value estimate triangulated through assessing sub-category export improvement potential in each vertical, and through comparing firm-level profit margins for highly innovative vs average firms
- Product focus from matching US proportion in high skill industries
- GVC integration based on uplifting exports in key markets to Australian average category share.

1 Increase based on extrapolation from aerospace and med tech analysis.

2 Base growth projected using 10-year historic CAGR for ANZSIC sub-divisions 18, 23 and 24. See appendix for full methodological details.

Source: AlphaBeta/McKinsey analysis

3.4 STRIVING FOR RESILIENCE AMID VOLATILITY

While studies of the manufacturing industry often focus on ways to improve competitiveness, it is important to remember that Australia is home to one of the most volatile manufacturing industries in the developed world. Even highly successful manufacturing companies can lose their advantage when their industry enters a period of contraction or if consumer tastes change. Therefore, more than just competitiveness, manufacturers must exhibit resilience to ensure longer-term performance.

Resilient firms can be defined as those that outperform their industries during periods of volatility by displaying higher than average earnings. This means that when revenues and profits slump, they survive, adapt and grow more quickly (or contract more slowly) than their industry peers.

Complementing its work on manufacturing competitiveness, AMGC has conducted detailed research into resilience. This found that Australian manufacturers, ranging from motor vehicle parts manufacturers to cheese producers, have experienced larger changes in fortune over the past three decades than their counterparts in other advanced economies. On average, output across Australian manufacturing sub-industries has swelled to 20% above trend during economic upswings, while contracting to 20% below this level during downturns. This compares with much more modest deviations of 14% in the UK, 10% in the US and 8% in Germany.[14]

3.5 THREE RESILIENCE STRATEGIES

Embedding a mindset of resilience will help Australia manufacturers navigate these highs and lows. It will also position the industry as an ongoing source of innovation and prosperity in the economy. Just as every manufacturer can be advanced, every firm has the ability to succeed through downturns if it identifies the source of volatility it is facing and adopts a corresponding resilience strategy.

AMGC's analysis reveals that many resilient manufacturers in Australia share similar features. For example, about 90% of resilient firms in the motor vehicle and parts industry are exporters, and more than 60% have strong international connections or participate in global value chains. As a result, these firms can rely on overseas customers to cushion falls in domestic demand. By contrast, in mining and construction equipment, more than 80% of resilient manufacturers are technical leaders. These firms typically invest heavily in research and development (R&D) and focus on unique product or market niches. In dairy manufacturing, three-quarters of resilient firms use flexible cost models, particularly in the way they manage suppliers and employees. This allows them to buffer temporary falls in revenue.

Based on its analysis, AMGC has identified three proven resilience strategies for firms.

- **Superiority:** superior firms possess an unassailable competitive advantage by offering technically superior products or services that are unique within the market, and highly valued irrespective of accompanying conditions.
- **Diversity:** diversified firms possess a competitive advantage across diverse product segments, service offerings or geographically diverse export markets. This enables them to respond to shifting consumer tastes or reduced overall demand.
- **Flexibility:** flexible firms possess an agile business structure allowing them to manage fluctuations in input costs or change industry focus in the event of a downturn.

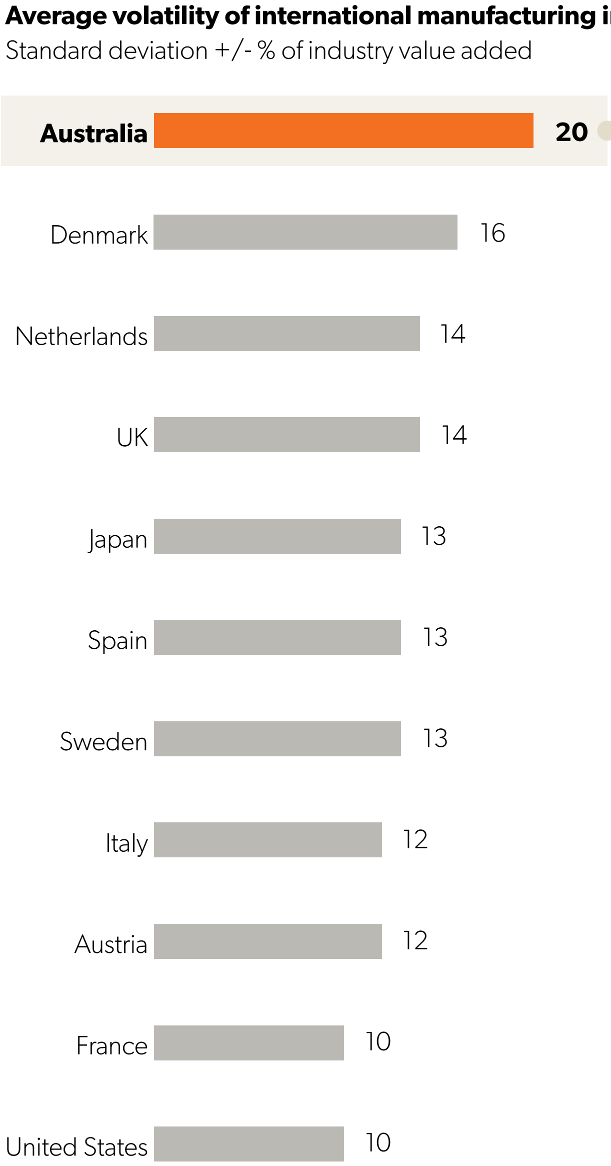
The concept of resilience as a distinguishing factor of success adds another layer to AMGC's competitiveness analysis. A key finding of AMGC's research is that manufacturing firms must be competitive and resilient in order to succeed in the long run.[15]

14 In this report, volatility refers to the average ratio of the standard deviation of fluctuation in an industry's output from a linear trend to the industry's size. See Appendix for volatility calculation methodology. This volatility is significant, even after accounting for structural changes and inflation.

15 Further details can be found in AMGC's report *Advanced Manufacturing: building resilience in Australian Manufacturing*, 2018.

3 BALANCING COMPETITIVENESS AND RESILIENCE

Exhibit 10 – Australia's manufacturing industry is one of the most volatile in the world



On average, Australian manufacturing sub-industries swell by 20% above their average size in upcycles and contract to 20% below their mean size in downturns – more so than in other countries

Factors driving Australia's volatility

1. Exchange rate volatility – AUD more volatile than other currencies
2. Graphic isolation – especially affected by cost fluctuations in transportation
3. Size and openness – small, open economies tend to be more prone to terms of trade shocks
4. Resource base – a large portion of our aggregate demand is victim to commodity price fluctuations

Note: Volatility calculated over period from 1996 to 2015 using Australian 2-digit manufacturing sub-industries and equivalently disaggregated overseas manufacturing industries, based on OECD data. See appendix for methodology.

> Companies must lead the transition by taking a series of actions to compete on value.

4 SOURCES OF COMPETITIVENESS

4 SOURCES OF COMPETITIVENESS

4.1 OVERVIEW

This section offers a detailed analysis of the three key sources of Australian manufacturing competitiveness – product cost, value differentiation and market focus – based on the aerospace and medical technology sub-industries. Overall, it finds that Australia has a product cost disadvantage compared with its international rivals – due in large part to differences in labour costs, transport costs and overheads. Even Australia's cost advantage in high-skilled labour (meaning that it is cheaper to hire such workers in Australia than in countries such as the US) is offset by the nation's relatively low capital efficiency and productivity. Addressing the sources of product cost disadvantage – most notably by boosting management quality – undoubtedly has a role to play in improving Australia's manufacturing competitiveness. Nonetheless, the most promising strategy for Australian firms is to differentiate their value proposition by pursuing technical leadership and unique service offerings. They must also refocus on high-potential export markets. Creating the conditions for future manufacturing success will require bold action to upskill the industry, boost industry-research collaboration, recalibrate and focus the R&D tax incentive and develop stronger linkages with global supply chains.

4.2 LIFTING COMPETITIVENESS BY REDUCING COSTS

4.2.1 Australia's product cost disadvantage

Overall, AMGC's analysis finds that Australian manufacturing has a product cost disadvantage relative to the international benchmark of between 15.1 percentage points in aerospace and 7.1 percentage points in medical technology. This is due primarily to differences in labour costs, transport costs and overheads (see Exhibit 11). Note that the US was selected as a representative international benchmark for both aerospace and medical technology because it is a leading developed country competitor and exporter in each category.

A sizeable proportion of the gap compared with the international benchmark is driven by labour costs.[16] However, it is important to note that productivity-adjusted labour costs are a combination of both wage levels and labour productivity. This is because Australian manufacturing's labour unit cost disadvantage is not primarily due to higher wages but more the nature of production in Australia. Specifically, factors such as the skills mix, business size and quality of management practices help to explain Australian manufacturing's disadvantage in labour costs.

> Product cost refers to the composition of costs that drive the final price of a produced good. These include variable costs (such as labour, materials, energy and transport), fixed costs (such as capital and overheads) and tax. In order to estimate the labour cost, AMGC has used a range of data sources to identify relative costs for Australian manufacturers when compared with an international benchmark.[17]

16 AlphaBeta/McKinsey manufacturing product cost competitiveness model.

17 The model calculated the price required to generate a fixed return on invested capital equivalent to the cost of capital. The relative size of each cost category for aerospace and medical technology companies was estimated using detailed data from the 2014 US Census of Manufacturers. For each cost category, industry-specific benchmarks were used to identify the relative cost (higher or lower) for Australian firms, resulting in an overall product cost comparison. This research draws on data sets including the OECD STAN database, EU KLEMS database, ABS and BLS data, and other reports on manufacturing.

Exhibit 6 – Product cost benchmarking suggests that Australian manufacturing has a cost disadvantage of 15.1 percentage points (ppt) in aerospace and 7.1 ppt in medical devices

	Aerospace			Medical technology		
	Share of unit cost	Gap to benchmark	Total ppt contribution	Share of unit cost	Gap to benchmark	Total ppt contribution
Productivity adjusted labour	28%	+32%	9.1	30%	+9.8%	3.0
Materials	48%	+3%	1.5	44%	+2.2%	1.0
Energy	1%	+48%	0.5	1%	+48%	0.5
Transport	8%	+13%	1.1	4%	+11%	0.4
Tax	1%	7 ppt	0.6	1.5%	7 ppt	0.5
Capital	4%	+33%	1.3	5%	+9.8%	0.5
Overheads	10%	+11%	1.0	14%	+10.0%	1.4
		Total unit cost difference =	**15.1**		Total unit cost difference =	**7.3**

Australia's unit labour cost disadvantage is **driven by lower labour productivity** (value added per hour), **not wages**. In both aerospace and medical devices, Australian productivity is lower than in the US; while in medical devices Australia has a **wage advantage**

Transport cost differential driven by relative cost to export to key EU markets, including internal freight. For **small, high-value medical devices the difference is smaller**

Higher overheads for Australian firms driven by **significantly smaller average firm size**, where overheads are a greater proportion of cost

In **aerospace**, the total cost difference is 15.1 ppt, driven primarily by differences of 9.1 ppt in labour, 1.1 ppt in transport and 2.3 ppt in capital/overheads.

In **med tech**, the total cost difference is 7.3 ppt, driven primarily by differences of 3.0 ppt in labour, 1.9 ppt in capital/overheads and 1.0 ppt in inputs.

Source: McKinsey/AlphaBeta competitiveness model; various cost input sources

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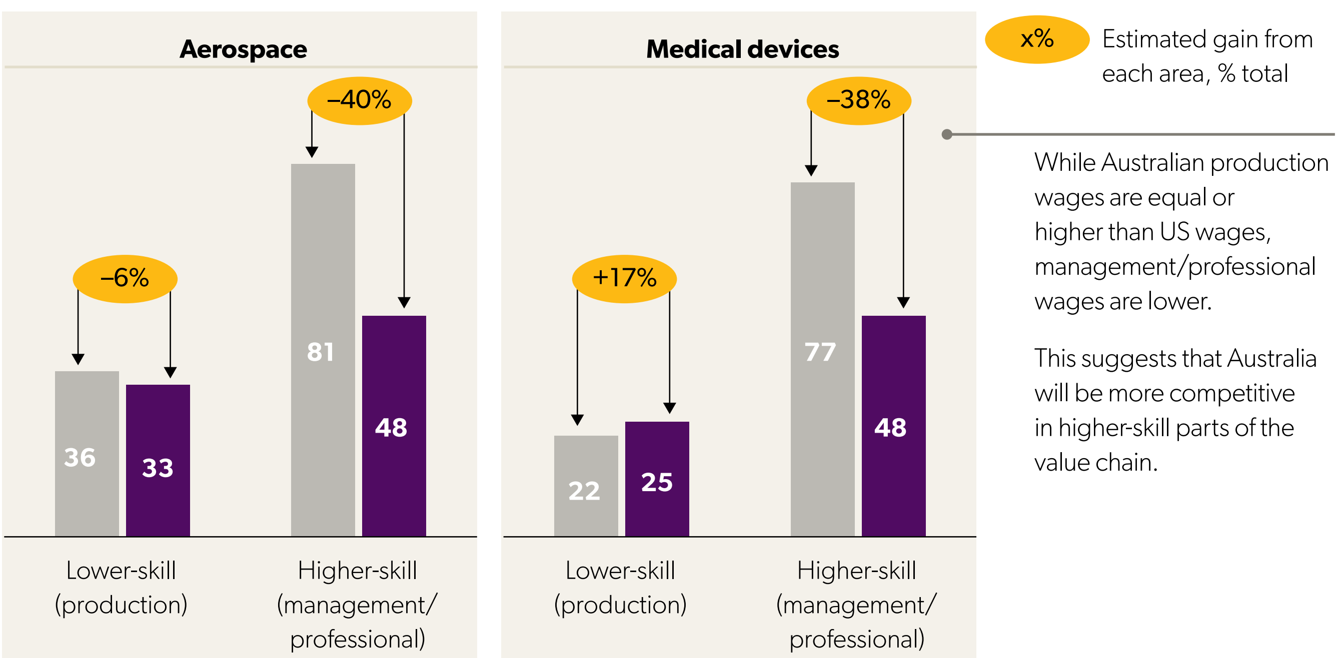
4.2.2 Cost advantage in high-skill labour

In general, AMGC's analysis finds that Australian manufacturing is unlikely to be able to compete on labour cost for low-skill jobs. Even relative to high-cost countries such as the US, Australian low-skill labour is comparatively more expensive: 9.8% higher than the international benchmark in medical technology and just under the benchmark in aerospace. However, Australia has a wage cost advantage for high-skill workers: 38% below the international benchmark in medical technology and 40% below in aerospace (Exhibit 12).[18] This means that the most competitive Australian manufacturers will often be those that have higher proportions of high-skill workers than foreign competitors. The decision by Ford to retain more than 1,000 design and engineering staff despite ceasing domestic production in Australia is a good example.

Australia's competitiveness in medical technology can be partly explained by its higher proportion of high-skill workers (26% of workers in the sub-industry have a bachelor's degree or higher versus 18% in the US).[19] By contrast, the larger gap in labour costs in aerospace can be partly explained by its relatively low-skill composition (17% with a bachelor's degree or higher versus 44% in the US), thereby failing to capitalise on our labour cost advantage (Exhibit 13).[20] The importance of skill mix suggests that a shift towards higher-skill composition or skill-intense production will be important if Australian manufacturers are to be more competitive in the future.

Exhibit 12 – Australia has a significant cost advantage in higher skill workers

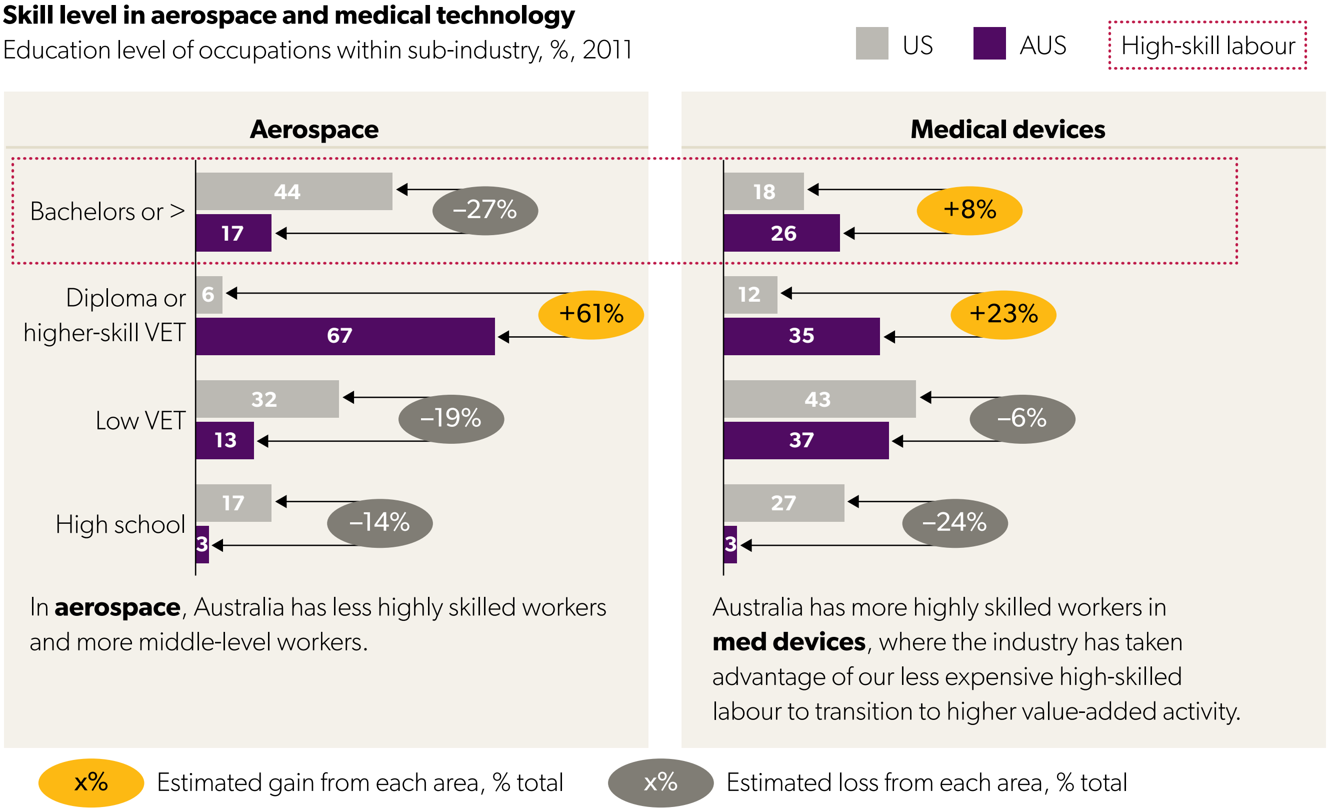
Wage differential by occupation, Australia and the US
$US/hr for occupation and industry, estimated[1], FY2014



1 US estimates based on US Census Bureau's Annual Survey of Manufactures.
2 Australian estimates based on mapping average wages for roles to mix of roles in each industry; 10-year average exchange rate of $0.88 AUD/USD.
Source: ABS series 6306; US Census Bureau Annual Survey of Manufacturers (ASM) 2014; RBA Forex data; McKinsey/AlphaBeta analysis

18 AlphaBeta/McKinsey analysis based on ABS series 6306.0: "Employee earnings and hours, Australia", US Census of Manufacturers 2014, and exchange-rate data published by the Reserve Bank of Australia.
19 AlphaBeta/McKinsey calculation derived from mapping education levels to occupations at 1-digit level using data from Australian Census (2011) and the US BLS Occupation-Industry Matrix (2011).
20 AlphaBeta/McKinsey calculation derived from mapping education levels to occupations at 1-digit level using data from Australian Census (2011) and the US BLS Occupation-Industry Matrix (2011).

Exhibit 13 – Some Australian industries do not take advantage of our cost advantage in high-skill workers



Note: Higher-skill VET defined as Cert III or IV in Australia and 'Some college, no degree' in US.
Source: Australian Census (2011); US BLS Occupation-Industry Matrix (2011). Calculated by mapping education levels to occupations at 1-digit level. AlphaBeta/McKinsey analysis

4.2.3 Lower capital efficiency and productivity

Labour productivity in Australian manufacturing is only 60–65% of the level of the international benchmark.[21] This more than offsets Australia's wage cost advantage in high-skill workers. Key drivers of labour productivity include management quality, which impacts efficiency; firm size, which impacts economies of scale and potentially the uptake of automation; capital intensity; and Industry 4.0 processes.

- **Management quality:** A previous study of more than 6,000 manufacturers across 21 countries evaluated national management performance against a set of common benchmarks including lean operations, performance management and talent management.[22] This research reveals that Australia has a larger tail of low-performing manufacturing companies than other advanced economies; Australian scores are on average 10% lower than US scores on average; see Exhibit 14 for details. Australia also has a shortage of managers with university degrees. Other countries have sought to boost the skill level and proportion of the workforce with tertiary education through policies such as encouraging greater enrolment in MEST subjects, attracting more workers into manufacturing, and skilled migration.[23]

21 AlphaBeta/McKinsey manufacturing product cost competitiveness model.
22 Bloom, Nick et al. (2007), 'Management Practice and Productivity: Why They Matter', *Management Matters*. Available at: www.growingjobs.org/downloads/management_practice.pdf
23 McKinsey & Company (2009), *Management Matters*.

- **Perception:** AMGC's research for its *Public Perceptions Report* found that older people are more likely to perceive manufacturing as important than younger Australians (see Exhibit 14). For example, around 85% of those aged 65 and older believe manufacturing is important to maintaining a strong Australian economy. Whereas, just under half (48%) of 18 to 24-year-olds feel the same way.

  This suggests the industry needs to do more to boost the perception of manufacturing among younger people, in order to influence their career choices and opportunities on offer.

In addition, almost three out of four Australians (72%) claim to have some familiarity with Australian manufacturing. AMCG's research found that most people still associate the manufacturing industry with the production of items like cars, traditional factories and manual labour. However, respondents did associate manufacturing with growing areas of production such as furniture, retail goods and mining. Associations with 'higher skilled' work and expressions that there should be 'more manufacturing in Australia' were mentioned for the first time in this year's survey. Respondents with a higher familiarity with manufacturing are more likely to recognise that Australian manufacturing is strong and that manufacturing jobs are more highly skilled than they were historically.

For example, while Australians who say they have a high familiarity with manufacturing still associate it predominantly with production (the process of putting something together), they are more likely to recognise that manufacturing is important, involves design and engineering, and is connected to well-paid and highly skilled jobs

Exhibit 14 – The importance of manufacturing by age group

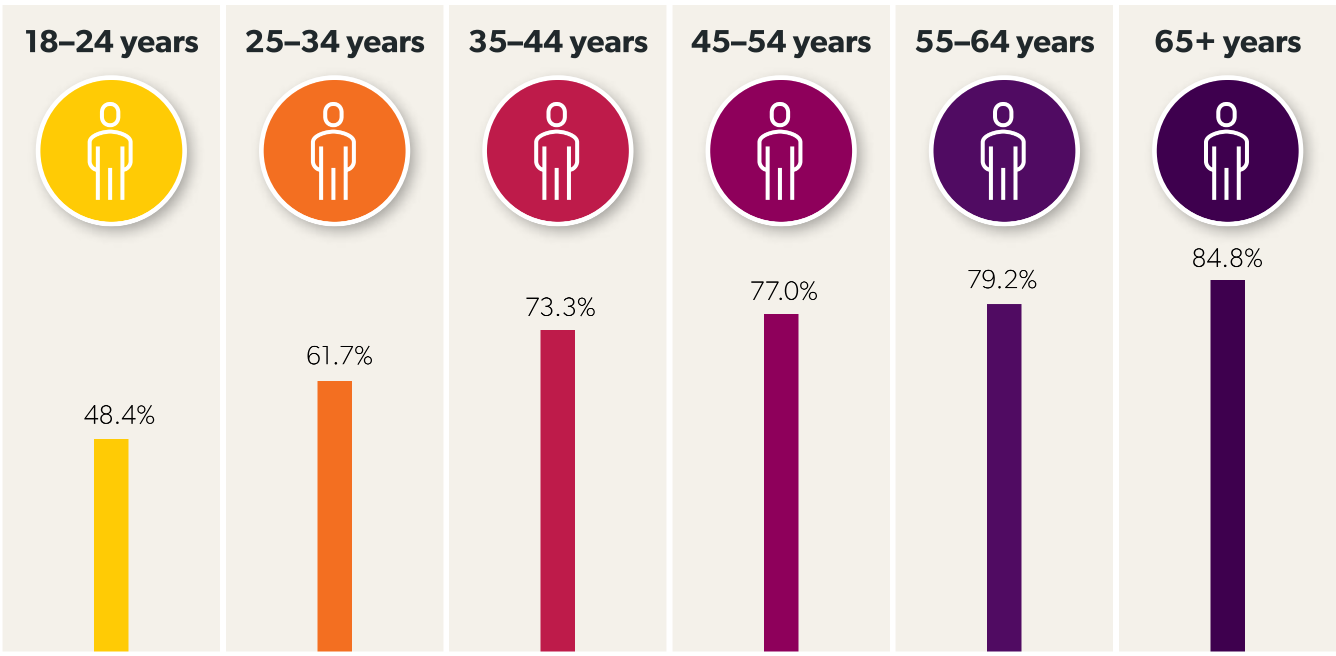
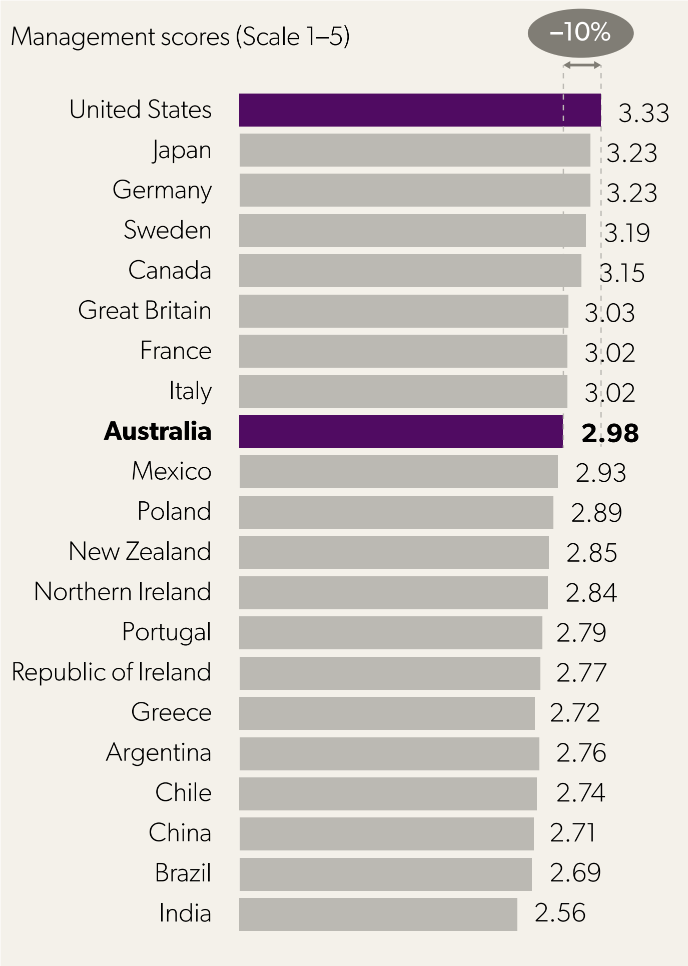
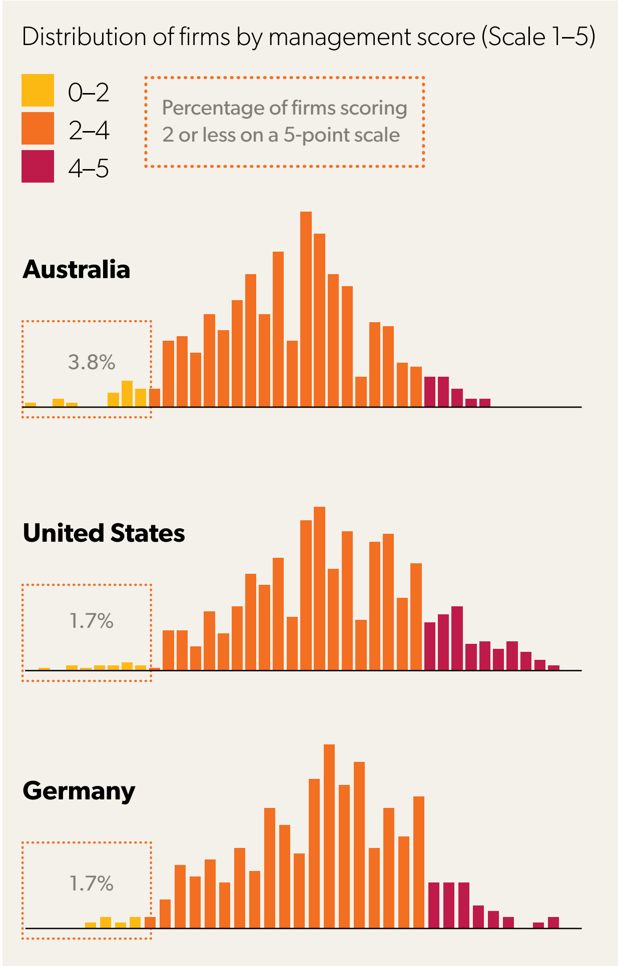


Exhibit 15 – Management practice could be improved in some Australian manufacturers

Australia lags significantly behind the US in manufacturing management practice …



… with a larger share of underperforming managers compared with other countries

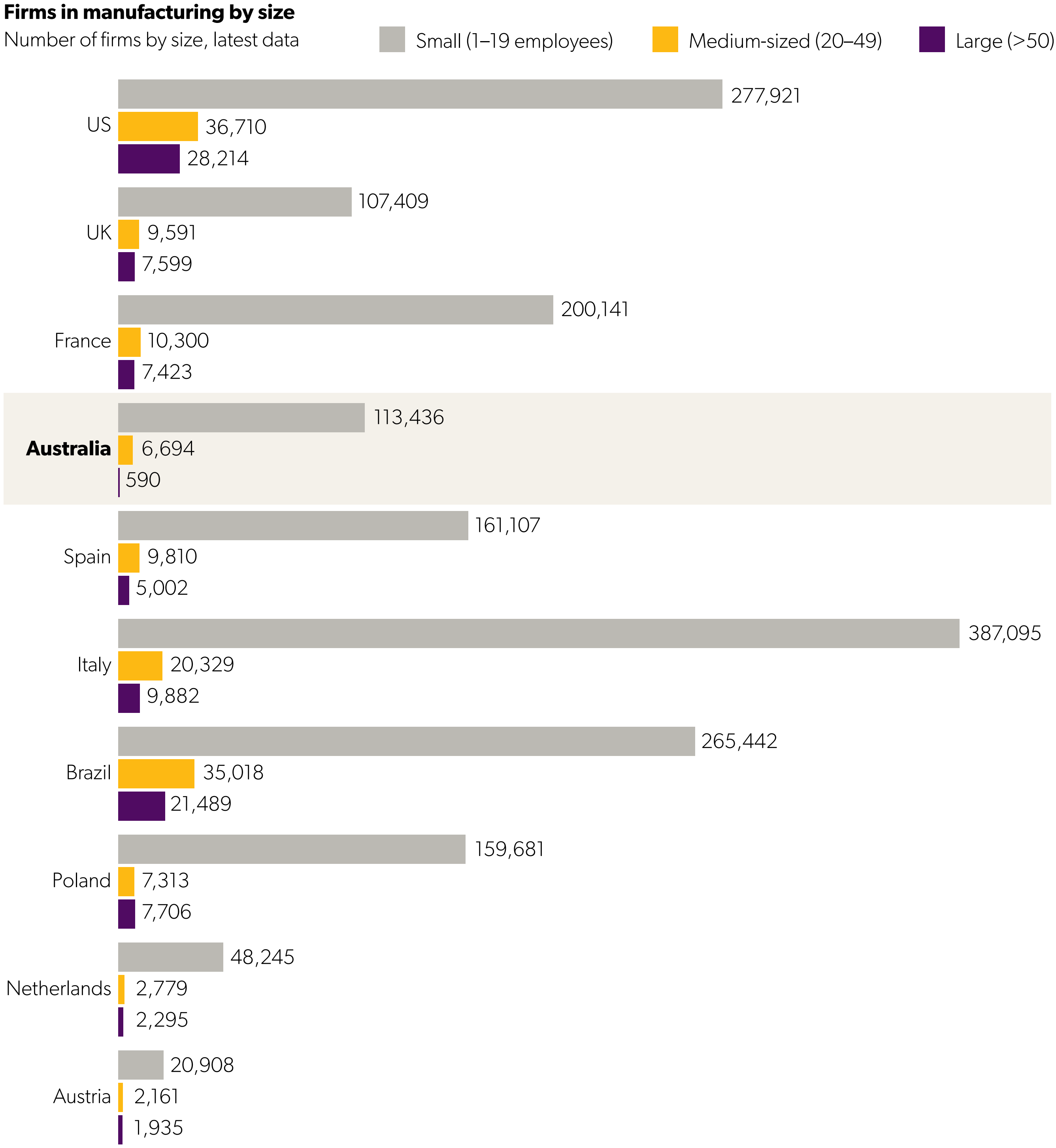


Source: McKinsey & Company, *Management Matters* 2008, 2009

- **Firm size:** Achieving economies of scale in manufacturing has been a challenge for Australia, due to limited local demand and the nation's distance from world markets. This, coupled with a system that encourages sole traders to incorporate, has resulted in a market dominated by small firms (see Exhibit 16). In aerospace manufacturing, Australia has 42 medium-sized companies and two large companies, compared to the US which has 472 medium-sized companies and 280 large companies.[24] In medical technology manufacturing, Australia has 44 medium-sized companies and six large companies, compared with 792 medium-sized companies and 667 large companies in the US.[25] This suggests that among Australian manufacturers, overheads are not spread across large volumes. Shorter production runs also make it harder to optimise production. Other countries have sought to overcome scale challenges by encouraging collaboration between companies, consortium formation in bidding for government contracts or entering export markets, and the pooling of R&D resources.

24 OECD (2012), Structural and Demographic Business Statistics.
25 OECD (2012), Structural and Demographic Business Statistics.

Exhibit 16 – Australia has a reasonable number of manufacturing SMEs but very few large firms



Note: Australia has numerous small firms in part as a result of a system which encourages sole traders to incorporate.
Source: OECD Structural and Demographic Business Statistics (2012)

- **Automation, capital intensity and digitalisation:** The gap between Australian manufacturing productivity and that of its peers can be partially explained by differences in capital intensity, automation and the slower uptake of digitalisation technologies.[26] This involves a transition from traditional factories and assembly lines to manufacturing settings, processes and supply chains that are linked by omnipresent connectivity. Today, innovations such as 3D printing allow physical products to be created from digital templates.[27] Just as the internet has created new value by connecting people digitally, the Internet of Things (as it matures) will support cyber-physical production systems in which products, machines, networks and systems communicate and cooperate with each other independently. Automation of complex tasks is likely to be augmented by advances in artificial intelligence. This will enable machines to learn through experience rather than relying completely on human instruction.
- International studies have indicated potential productivity gains from the adoption of digitalisation technology of up to 25% in excess of conversion costs, and an overall gain of 5–8%.[28] Similar Australian studies are yet to be completed, and good quality data is not available on the uptake of more digitalisation in Australia versus other countries. However, greater integration of digital production, automation and data analysis will improve production processes and allow more distinct value offerings.

4.3 LIFTING COMPETITIVENESS BY INCREASING VALUE DIFFERENTIATION

4.3.1 Importance of technical leadership and service offering

In addition to hiring more high-skill labour – an area where Australia has a relative cost advantage – Australian manufacturers can compete on the world stage by differentiating their value proposition. This is likely to involve pursuing superior technology or design innovation that results in materially improved performance. Alternatively, it could mean developing an enhanced service offering that makes products easier to use, upgrade or tailor to customer needs.

To understand what manufacturing customers value beyond being able to purchase an affordable product, AMGC conducted comprehensive consultations with approximately 30 industry experts and international purchasing managers. This panel were asked to identify and weight the importance of other factors that influenced the selection or procurement of a final good or intermediate component from Australia. These factors included product innovation, design, reputation, flexibility and service support (see Exhibit 17).

Purchasing managers and customers identified technology and performance leadership as the most important factors other than cost, with an approximate 60% weighting collectively. AMCG's *Public Perceptions Report* also demonstrates that 58% of customers are happy to pay more for products made in Australia, because they believe they will be high quality.

The upshot is clear – Australia, with its small domestic market and cost disadvantages – needs to appeal to international purchasing managers with innovative design and leading technology across a smaller-scale and niche product line. However, delivery flexibility (particularly in the case of aerospace) and the availability of services support (in medical technology) were also considered to be key reasons for purchasing from Australian manufacturers.

26 AiG and AAMC have commented that Australian manufacturers urgently require capital investment and upgrades.

27 McKinsey & Company (2015), *Manufacturing's Next Act*. Available at: www.mckinsey.com/business-functions/operations/our-insights/manufacturings-next-act

28 Boston Consulting Group (2015), *Industry 4.0: The future of productivity and growth in manufacturing industries*. Available at: https://www.bcgperspectives.com/content/articles/engineered_products_project_business_industry_40_future_productivity_growth_manufacturing_industries/

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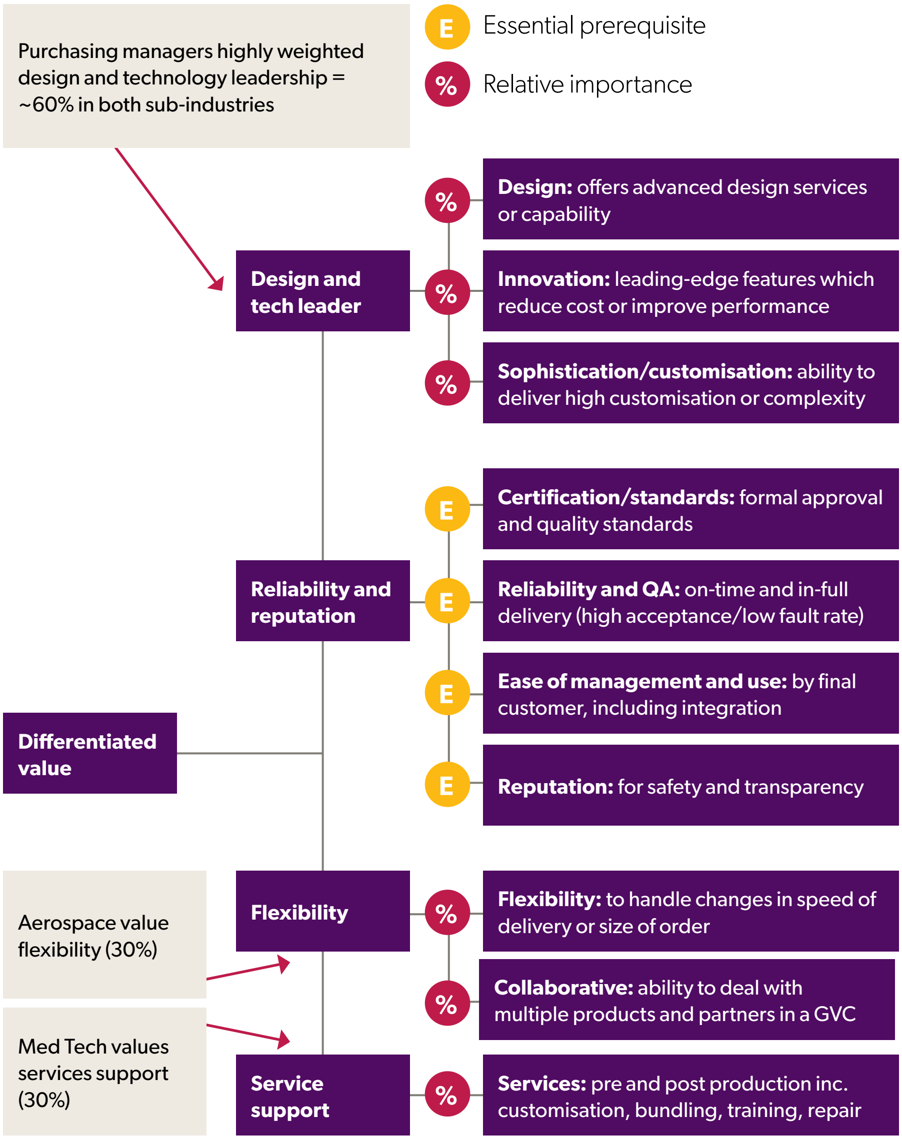
Exhibit 17 – International purchasing managers report that technical leadership and the availability of service support are the main reason they buy Australian products



Notes: For aerospace, relevant experts were international purchasing managers in OEMs and primes. For med tech, relevant experts were final customers and exporters' view of what mattered to their final customers.
Source: Interviews

Key insights and quotes

- **Aerospace:** *"Companies need to develop solutions targeting real problems facing the industry"*
- **Aerospace:** *"Value to end user is critical in competitive aircraft market, e.g. weight reduction can be worth far more than the component itself"*
- **Med Tech:** *"Hospitals of tomorrow will want equipment customised to their information systems"*
- **Aerospace:** *"Certification to required standards is a given"*
- **Med Tech:** *"This is essential given poor patient outcomes"*
- **Aerospace:** *"This is table stakes" "There are high-costs to faults and schedule disruption"*
- **Med Tech:** *"Purchasing managers care most about product safety, given risks of poor patient outcomes"*
- **Aerospace:** *"Assessing bid proposals ultimately boils down to trust"*
- **Aerospace:** *"Ability to ramp up production quickly is of great value but rarely need to ramp down"*
- **Aerospace:** *"The ability for suppliers to work with other suppliers makes things much easier for the prime or OEM"*
- **Med Tech:** *"Final customer cares a lot about simplicity in accessing services and managing product. This is a key differentiating factor."*

4.3.2 Actions that support technical leadership

To understand which government and industry-led actions matter most in fostering technical leadership, AMGC analysed the experience of 50 successful Australian aerospace and medical technology companies (see Exhibit 18). This firm-level analysis of Australian success stories revealed five key ingredients that have helped to create technology leadership in Australia's top firms: public research funding, commercial R&D support, university collaboration, capability transfer from another industry, and strategic government demand. Nonetheless, there were significant differences across the two sub-industries. In aerospace, 44% of successful exporters gained technology or performance leadership support due to capability transfer from another industry, 28% from university collaboration, 20% from strategic government procurement and 20% from Australian content requirements (see Exhibit 19).[29] By contrast, in medical technology, 60% gained technology or performance leadership support from university collaboration, 56% from R&D grants or tax incentives, and 44% from research grants.[30]

These differences are likely based on each sub-industry having a different model for innovation.[31] In aerospace, innovation requires the development of complex systems, which involves high levels of collaboration and high externalities. Potential policy instruments to encourage this outcome include having a secure source of demand and improved collaboration with universities. By contrast, in medical technology, innovation requires the application of technology with a high science content. This involves high financing costs for high-risk efforts and the commercialisation of research. Potential policy instruments innovation include support for basic research, support for business-led R&D, private capital, and improved collaboration with universities.[32]

29 AlphaBeta/McKinsey analysis of 50 firms, using expert interviews, company websites and press search.

30 AlphaBeta/McKinsey analysis of 50 firms, using expert interviews, company websites and press search.

31 Martin, S. (2000), 'The nature of innovation market failure and the design of public support for private innovation'. Available at: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.196.7452&rep=rep1&type=pdf>

32 ibid.

4 SOURCES OF COMPETITIVENESS

Exhibit 18 – To understand what enables technical leadership, we analysed 50 successful Australian aerospace and med tech manufacturers

Question: what materially contributed to the firm developing the technology that made it successful?		
Public research	Fundamental research grant	Was there an original grant for fundamental research (e.g. from ARC, NHMRC) that materially contributed to development?
Govt support for commercial R&D	R&D tax incentive	Did an R&D tax incentive materially contribute to development?
	Targeted R&D	Was there a targeted R&D or other grant that materially contributed to development?
Collaborative R&D	University/institute collaboration	Was there a relationship with a university or a research institution (CSIRO, CRC) that materially contributed to development?
	University talent spin-out	Was there a talent spin-out from a university or research institute that materially contributed to development?
Industry collaboration	Cluster	Did a cluster or partnership materially contribute to development?
	Coordination	Was there direction coordination by an industry body that contributed to development?
	Firm spin-out	Did the development come as a spin-out from a local or foreign firm?
	Capability transfer	Did a capability transfer from another industry or company materially contribute to development?
Govt procurement/ participation	Government procurement	Was the development materially supported by a government procurement contract?
	Australian content requirements	Was the development materially supported by Australian or SME participation requirements?
Private financing	Foreign direct investment	Was the development initially funded by foreign direct investment?
	Private capital (VC/PE)	Did the idea receive early-stage/PE funding?
	Anchor private contract	Was the development materially supported by an anchor private contract?
Policy or other	Regulatory change	Was there a regulatory change that supported the development?
	FTA/Export	Did an FTA or export assistance unlock a critical market to enable scale in development?
	Other	Other government or philanthropic assistance

Source: AlphaBeta/McKinsey analysis

Med Tech

Aerospace

Companies

Med Tech: respiri, impedimed, SomnoMed, Simavita, GREY, QuickSmart, signostics, biota, pSivida, CSL, cell therapies, SIRTeX, mesoblast, nanosonics, Osprey Medical, ResMed, Cochlear, Uscom, Oventus, átomo, Dynek Sutures, Cook Medical, avita medical, Acrux, NiSM, Admedus

Aerospace: Airbus Group, Mahindra Aerospace, Boeing, Levett Engineering, Electromold, Hawker Pacific, Thales, Safran, Quickstep, Broens, cablex, BAE Systems, Nova Systems, BEAK, aerosonde, Thomas, RUAG, Marand

Exhibit 19 – Technical leadership in Australian manufacturing firms was enabled by government R&D support and procurement policies

What factors materially impacted development of technology	Aerospace Proportion of firms	Med Tech Proportion of firms
Fundamental research grant	0%	44%
R&D tax incentive	0%	52%
Targeted R&D	12%	56%
University/institute collaboration	28%	60%
University talent spin-out	8%	28%
Part of cluster or partnership	20%	20%
Coordination by industry body	4%	0%
Spin-out from local or foreign firm	0%	20%
Capability from other industry or firm	44%	4%
Government procurement	20%	12%
Australian content requirements	20%	4%
Foreign direct investment	8%	0%
Venture capital	8%	56%
Anchor private contract	20%	24%
Regulatory change	0%	12%
FTA/Export assistance	8%	16%
Other govt or philanthropic grants	28%	8%

Frequently cited
Less cited factor

In aerospace, the biggest enablers of technology/performance leadership were government/private demand, research collaboration and capability transfer from another industry.

In med tech, the biggest enablers of technology/performance leadership were research grants, commercial R&D incentives, university collaboration and private capital funding.

Different innovation models in these sub-industries may explain the different factors. In aerospace, the innovation model relies on complex systems. In med tech, the innovation model relies on advances in science.

Source: Expert interviews; company websites; press search. AlphaBeta/McKinsey analysis

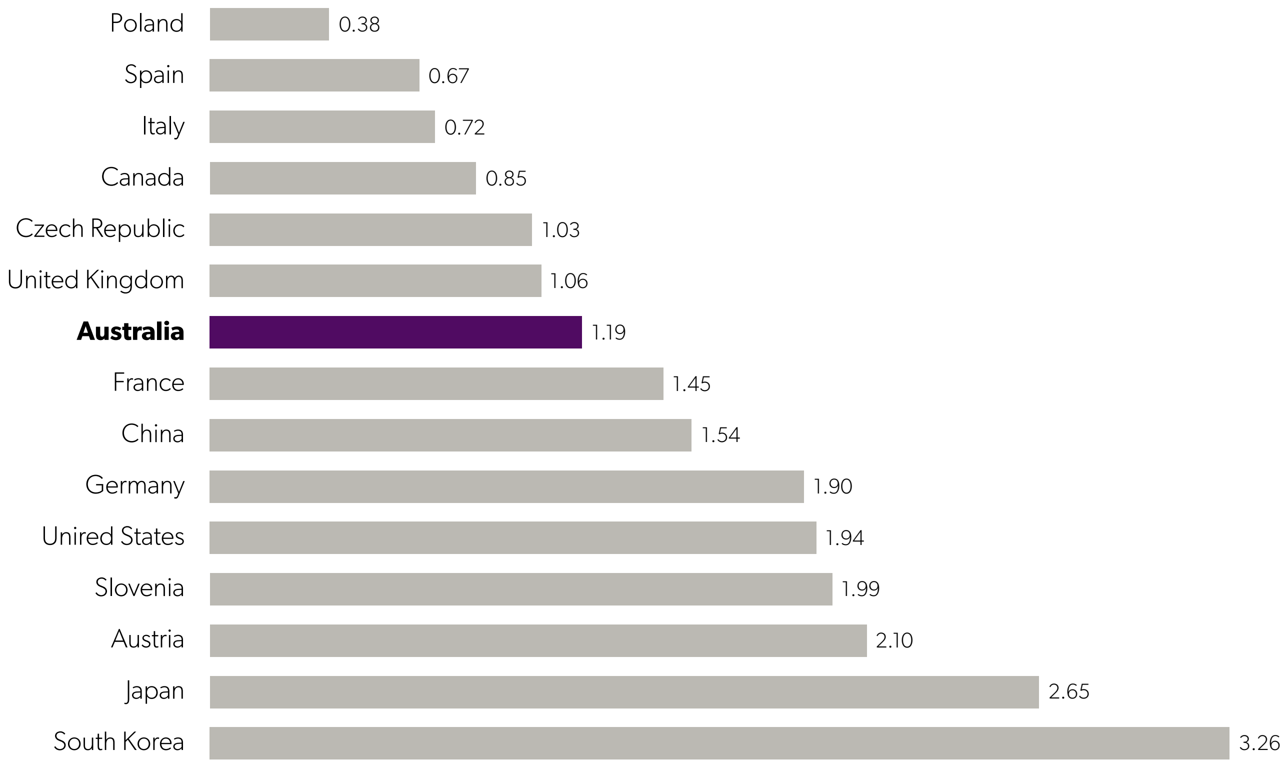
4.3.3 Current manufacturing skills mix and spending on R&D

Given the clear importance of technical leadership, Australian companies should be investing more heavily in R&D and employing a greater share of high-skilled workers. However, this is not the case. While Australian businesses currently spend more on R&D as a proportion of GDP than peers such as Canada or the United Kingdom (UK), they rank well below many key OECD competitors (see Exhibit 20). For example, Australian businesses' expenditure on R&D is the equivalent of 1.19% of GDP, while in Germany it is 1.90%, US 1.94%, Japan 2.65% and Korea 3.26%.

Australia also has a low utilisation of high-skill workers relative to the US across many manufacturing sub-industries (see Exhibit 21). For example, the proportion of workers with higher skills is larger in the US than in Australia in computer and electronics manufacturing (46 percentage points difference), photographic and optical manufacturing (34 percentage points), and aircraft manufacturing (31 percentage points). These skill deficits are particularly stark given that Australia, as noted above, has a significant cost advantage in higher-skilled workers: as much as 40% in some industries. Given Australia's wage advantage in higher-skill roles, shifting a larger proportion of the nation's employment into non-production roles and more skill-intense sub-industries represents an opportunity to improve competitiveness and increase productivity.

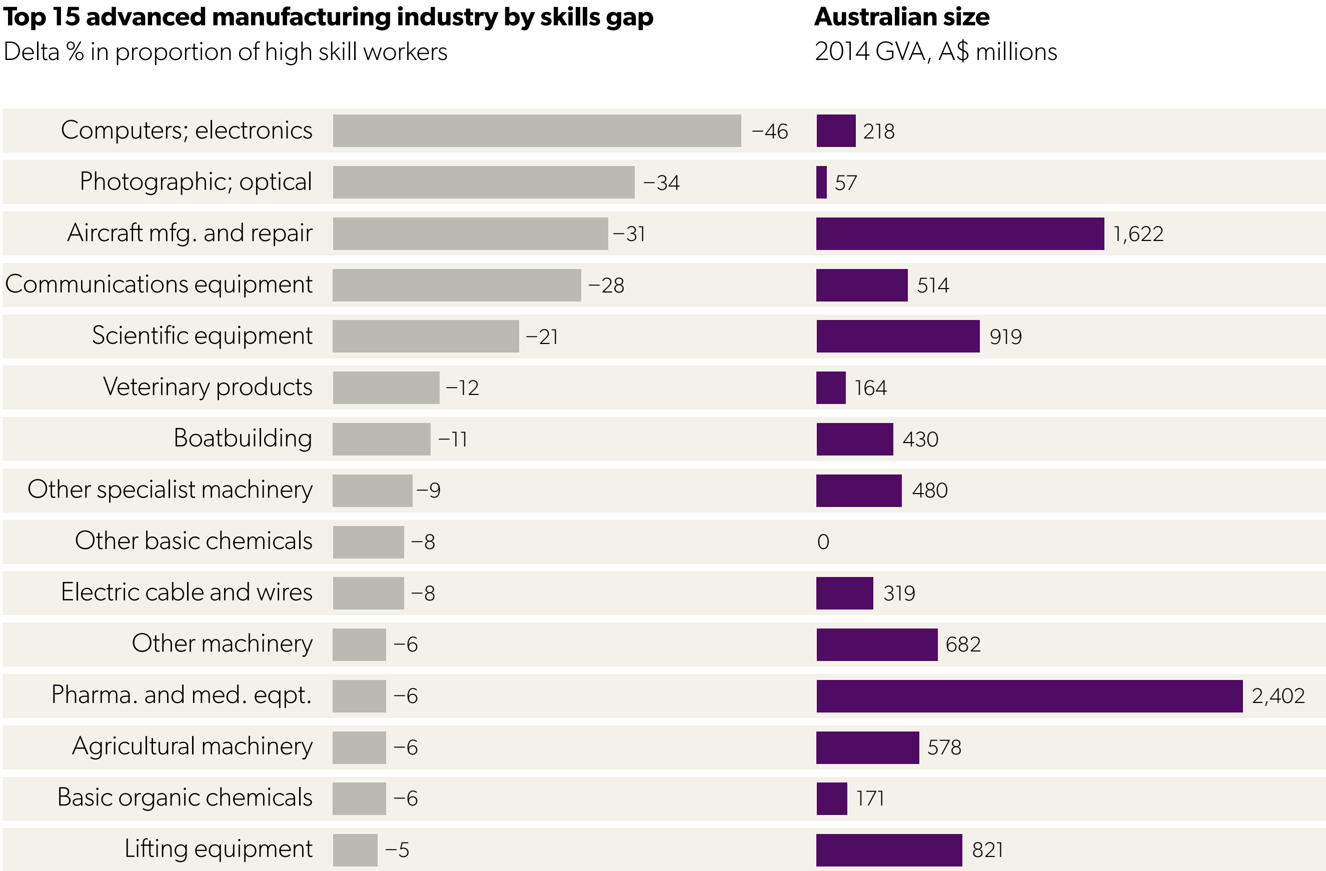
Exhibit 20 – Australian business expenditure on R&D is weaker than that of many key OECD competitors

Business expenditure on R&D (BERD) as a proportion of GDP
%, 2013



Source: OECD Main Science and Technology Indicators

Exhibit 21 – A number of sizeable manufacturing industries in Australia have large skill gaps compared with US equivalents, implying significant upside from boosting skill levels



Source: ABS table builder OCCP – 1 Digit Level by INDP – 4 Digit Level; ABS 8155.0; BLS statistics; AlphaBeta/McKinsey analysis

4.3.4 Current industry-research collaboration

Australian manufacturing could improve its level of research-industry collaboration, which would help to drive technical excellence among firms.[33] While Australia ranks poorly on OECD measures of research-industry collaboration,[34] several commentators have noted problems with these statistics. Some have queried the definition of 'innovation-active' businesses. Others have suggested the ranking is driven, in part, by a long tail of sole traders and micro-businesses (0–4 employees) that are not well suited to collaborative research projects with large research organisations due to a mismatch in size and capacity.

Similarly, it is argued that the ease of incorporation in Australia has driven many sole-trader service providers to register as manufacturing companies. As such, it is argued, Australia's ranking reflects the make-up of Australia's manufacturing industry rather than underperformance in collaboration.

Further insights can be drawn by analysing domestic information on all businesses collaborating with any institution. If micro-businesses are excluded, this analysis shows weak collaboration among small businesses and improved levels of collaboration among medium- and larger-sized businesses. Specifically, 18.6% of manufacturing firms with 5–19 employees are estimated to collaborate for the purpose of innovation with any other entity

33 Department of Industry (2016), *R&D Tax Incentive Review Issues Paper*, Canberra. Available at: <https://www.business.gov.au/~/media/Business/RDTI/Review/Research-and-Development-Tax-Incentive-Issues-Paper-PDF.ashx?la=en>

34 OECD (2016), Innovation Statistics and Indicators. Available at: <http://www.oecd.org/innovation/inno-stats.htm#indicators>

(including other firms and research institutions), compared to 18.4% of firms with fewer than five employees, and 19.7% of all manufacturing firms.[35] Larger firms collaborate significantly more; 24.6% of firms with 20–199 employees and 34.2% of firms with 200+ employees collaborating with other entities, including researchers. Furthermore, in 2013–14, only 9.5% of companies registering projects under the R&D Tax Incentive program indicated they had collaborated with another organisation.[36] Overall, the relatively low rate of collaboration among small businesses is problematic given that the vast majority of Australian manufacturing firms are small.

4.3.5 Current alignment between public research and business-led R&D

The relationship in Australia between public research funding and commercial research could be made stronger, in part through increased collaboration or institutionalised through applied research organisations such as Fraunhofer Society or UK Catapults. While there are many categories of public research funding, with different societal and economic objectives, a high-level comparison of public research and business-led R&D indicates weak overlap in the areas of expenditure (see Exhibit 22). For example, engineering receives only 10.4% of public research funding (including for research led by not-for-profit, higher education and government institutions), versus 39.7% of business-led R&D.[37]

35 OECD (2016), Innovation Statistics and Indicators. Available at: <http://www.oecd.org/innovation/inno-stats.htm#indicators>

36 Department of Industry (2016), *op. cit.*

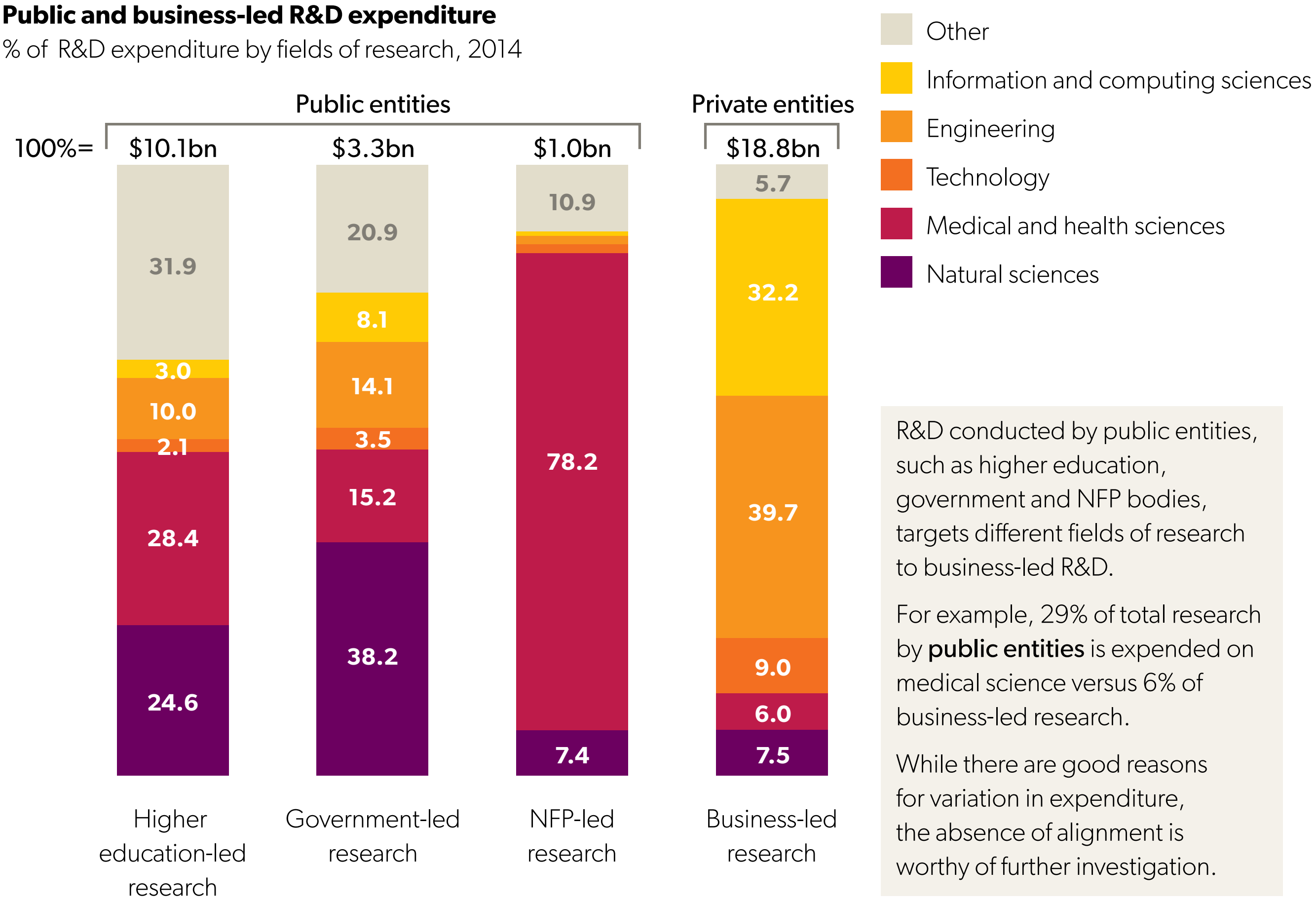
37 ABS series 'Research & Experimental Development' 8104.0 (Business), 8109.0 (Government & Private NFP), and 8111.0 (Higher Education Institutions).

38 Australian Technology Network/Ai Group (2015), *Innovate to Prosper: Ensuring Australia's Future Competitiveness through University-Industry Collaboration*. Available from: <https://www.atn.edu.au/siteassets/publications/atninnovateprosper.pdf>

Similarly, medicine and health sciences receive 28.8% of public research expenditure, versus 6.0% of business-led R&D expenditure. There are good reasons for this, including Australia's historic research strengths and the societal benefits associated with advances in health care. However, Australian medical technology and pharmaceutical exports account for a significantly smaller share of overall exports. This implies a weaker relationship between research investment and the nation's ability to commercialise discoveries in this area.[38]

This Manufacturing Competitiveness Plan does not consider whether this alignment is problematic. Further analysis could be undertaken in subsequent plans. However, we note that other countries allocate funds more widely to industry with potential for commercial growth. One example is South Korea which has focused more explicitly on advanced manufacturing. Other small countries adopt 'fast follower' strategies in some industries, with a focus on translational research.[39] The weak alignment in Australia could be explained, in part, by low collaboration rates between research and industry.

Exhibit 22 – There is minimal overlap between the fields of research targeted by public research entities and commercial entities



R&D conducted by public entities, such as higher education, government and NFP bodies, targets different fields of research to business-led R&D.

For example, 29% of total research by **public entities** is expended on medical science versus 6% of business-led research.

While there are good reasons for variation in expenditure, the absence of alignment is worthy of further investigation.

Note: R&D expenditure includes capital expenditure, scholarship and labour costs, experimental product development etc.
Source: ABS series 8111.0 'Research & Experimental Development, Higher Education Institutions'; ABS series 8104.0 'Research & Experimental Development, Business'

39 The Government of the Republic of South Africa (2002), South Africa's National Research and Development Strategy, Pretoria. Available at: <http://www.cepal.org/iyd/noticias/pais/0/31490/Sudafrica_Doc_1.pdf>

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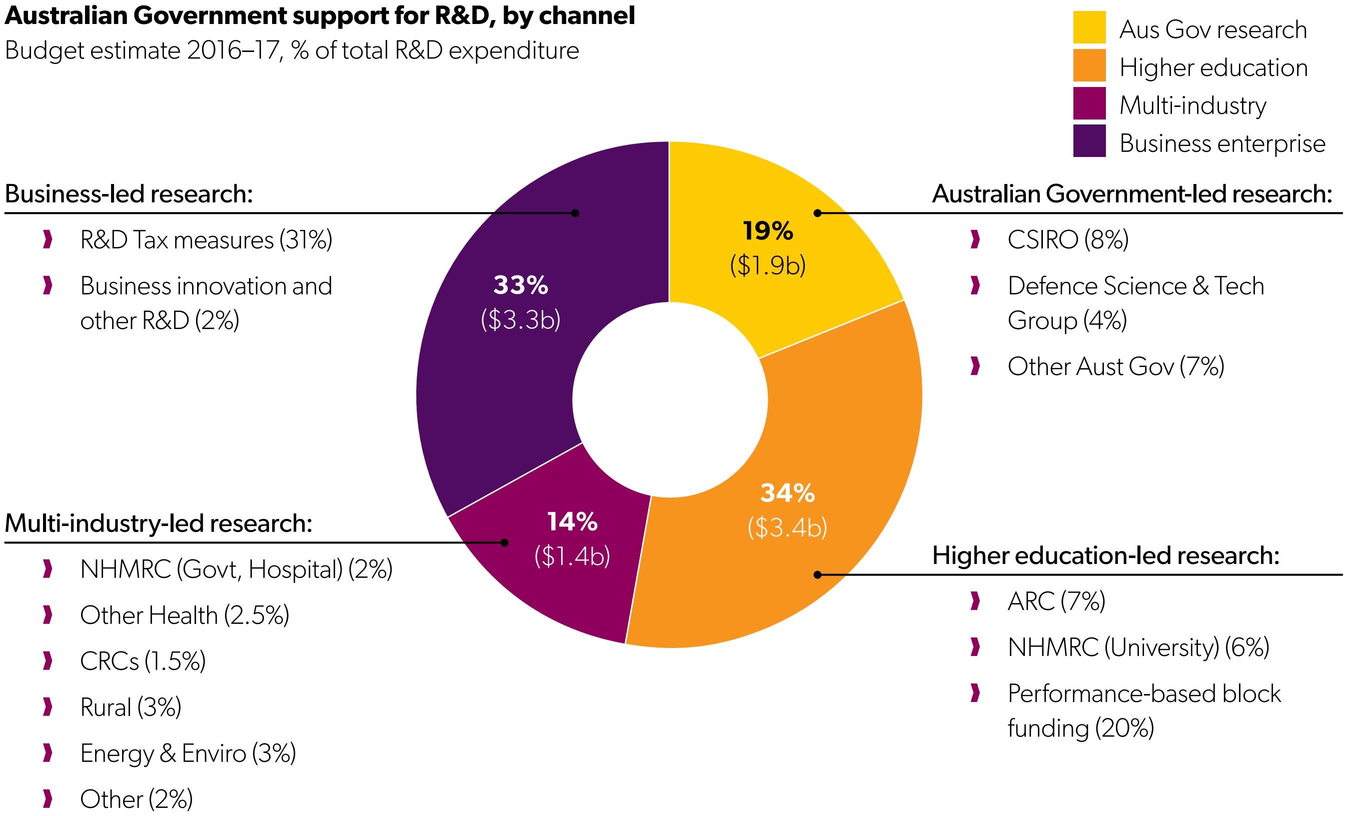
Exhibit 23 – The Australian Government provides $10.1bn in research and development, with 1/3 allocated to busienss-led research



Source: 2016–17 Australian Government 'Science, Research and Innovation' Budget Tables

Government support for R&D in Australia is sub-optimally designed

As noted by the OECD, governments support R&D because market failures generally cause enterprises to underinvest in research where the private rate of return to R&D investments is lower than the social rate of return.[40] The Australian Government provided $10.1 billion in support of research and experimental development in 2016–17, delivered via 15 government departments and agencies. This expenditure included $3.3 billion (33%) for R&D led by businesses via the R&D Tax Incentive scheme; $1.9 billion (19%) for R&D led by government bodies; $1.4 billion (14%) for research led by multiple industries; and $3.4 billion (34%) for research led by higher education institutions (see Exhibit 23).

The Australian Government's primary form of support for business-led R&D is the $3.3 billion R&D Tax Incentive scheme which is complemented by other smaller programs to support business innovation. These include CRCs and CRC-Ps, Accelerating Commercialisation, the new BRII pilot program[41] and the ARC Linkage Projects[42] program. However, the current mix of funding types and the design of the R&D Tax Incentive does not maximise the achievement of objectives including: (1) Encouraging investment by firms in R&D with different risk profiles (both medium and higher risk) and different time horizons (both short- and longer-term); (2) Ensuring that minimal government funding is provided to R&D activity that would have occurred without the incentive. Overall, this means that the funding mix is not likely to maximise investment by firms in R&D across different risk profiles, spillover benefits and time horizons.

40 OECD (2003), 'Tax Incentives for Research and Development: Trends and Issues'. Available at: <http://www.oecd.org/science/inno/2498389.pdf>

41 The Business Research and Innovation Initiative provides grants to eligible businesses to address five selected challenges. For further information, see: <http://www.minister.industry.gov.au/ministers/hunt/media-releases/grants-help-businesses-meet-public-sector-challenges>

42 The Australian Research Council's Linkage Projects provide funding to eligible organisations to support R&D initiatives that are undertaken to acquire new knowledge, and that involve collaboration and risk or innovation. For further information, see: <http://www.arc.gov.au/linkage-projects>

Australia is an outlier when it comes to the mix of assistance it provides for business-led R&D. This assistance can be broadly categorised as 'direct' and 'indirect'. The OECD defines direct assistance as the provision of grants and payments for R&D services, and indirect assistance as the provision of tax incentives including allowances and tax credits.[43] About 90% of the Australian Government's assistance for business-led R&D is provided via indirect means, primarily through the R&D Tax Incentive (see Exhibit 23). This weighting toward indirect assistance is much higher than in other OECD countries such as Germany (0%), the US (27%) and the UK (50%). A peer country with a similar level of indirect assistance, Canada (at 86%), recently opted to streamline its tax incentive and transition to a higher proportion of direct support.[44]

The difficulty with the existing funding mix is that different types of support for business-led R&D, namely direct assistance versus indirect assistance, are designed to respond to different market failures and stimulate different types of R&D expenditure.[45] Specifically, the OECD suggests that "tax credits are used mostly to encourage short-term applied research, while direct subsidies are directed to more long-term research"[46] and that tax-based measures, "unlike direct funding of business R&D … do not typically allow governments to direct business R&D into areas with high social returns (e.g. technological fields with significant spillovers)".[47] There are still good reasons to use indirect forms of assistance, such as tax credits, allowing markets to determine the allocation of R&D investment and create greater administrative simplicity. However, the current mix in Australia may limit the potential for government to incentivise and promote investment by firms in longer-term, higher-risk R&D that might have high spillover benefits and improve Australian manufacturing's export competitiveness.

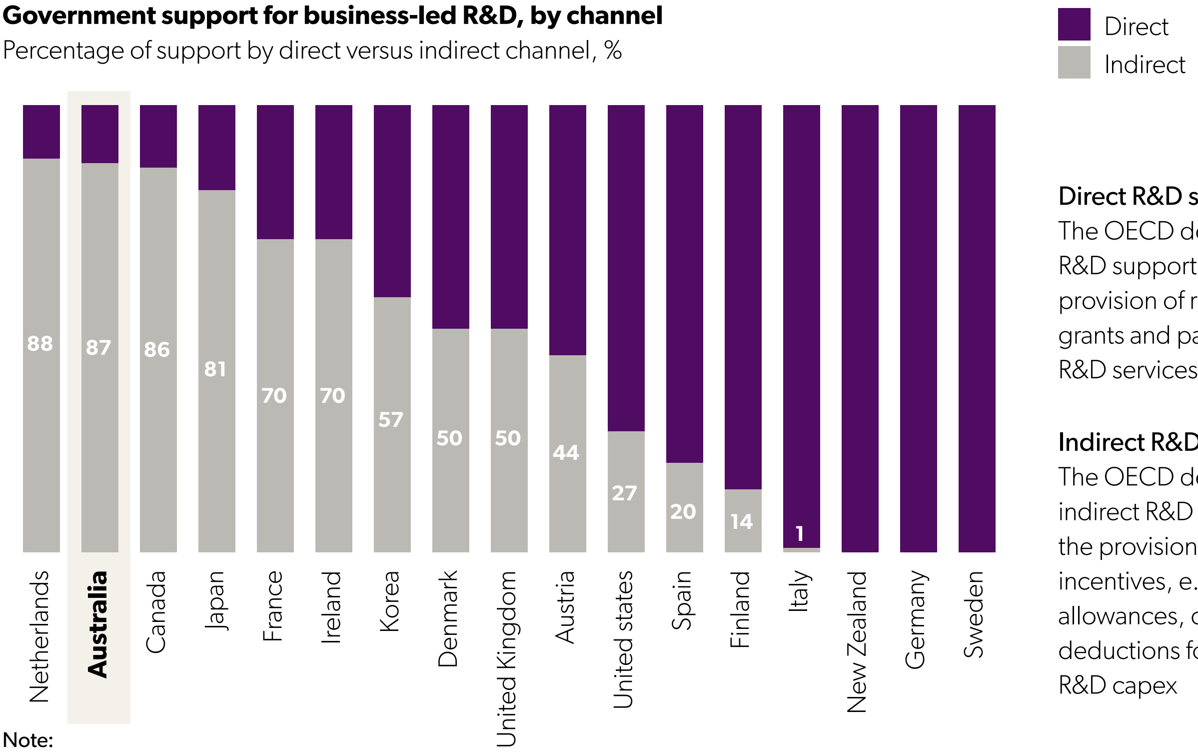
Another challenge is that the current design of the R&D Tax Incentive scheme does not guard against public expenditure on activity that would have happened even without that public support ("infra-marginal activity"). Analysis conducted by the Centre for International Economics on the R&D Tax Incentive found additionality (increased private investment in R&D)[48] of 0.3–1.0 dollar per dollar of tax forgone for large companies and 0.9–1.5 per dollar of tax forgone for SMEs.[49] The Review of the R&D Tax Incentive conducted by Ferris, Finkle and Fraser noted that "these magnitudes imply that around 10–20 percent of the total R&D registered would not be undertaken in the absence of the program".[50] These figures do not imply strong additionality. While the review acknowledged that there "are limits in the ability to target additional R&D in a volume-based scheme", there are ways to improve the effectiveness of the scheme, which are explored further in Section 5.

> The OECD suggests that 'tax credits are used mostly to encourage short-term applied research, while direct subsidies are directed to more long-term research'.

43 OECD (2003), 'Tax Incentives for Research and Development: Trends and Issues'. Available at: <http://www.oecd.org/science/inno/2498389.pdf>
44 OECD (2012), Science, Technology and Industry Outlook, 'Tax incentives for R&D and Innovation'. Available at: <https://www.oecd.org/media/oecdorg/satellitesites/stie-outlook/files/policyprofile/STI%20Outlook%2012_%20PP%20Actors_RD%20Tax%20incentives.pdf>
45 OECD (2010), 'R&D Tax incentives: rationale, design, evaluation'. Available at: <http://www.oecd.org/innovation/policyplatform/48141363.pdf>
46 OECD (2010), 'R&D Tax incentives: rationale, design, evaluation'. Available at: <http://www.oecd.org/innovation/policyplatform/48141363.pdf>
47 OECD (2003), 'Tax Incentives for Research and Development: Trends and Issues'. Available at: <http://www.oecd.org/science/inno/2498389.pdf>
48 Additionality refers to the increased private investment in R&D that occurs due to the programme. See: Finkel, Ferris, Fraser (2016), *Review of the R&D Tax Incentive*. Available at: <https://www.business.gov.au/assistance/research-and-development-tax-incentive/review-of-the-randd-tax-incentive>
49 Centre for International Economics (2016), *R&D Tax Incentive Programme Review*.
50 Finkel, Ferris, Fraser (2016), *Review of the R&D Tax Incentive*. Available at: <https://www.business.gov.au/assistance/research-and-development-tax-incentive/review-of-the-randd-tax-incentive>

Exhibit 24 – Australia is an outlier in how it publicly supports business-led R&D, with ~90% of funding provided via indirect channels

Government support for business-led R&D, by channel
Percentage of support by direct versus indirect channel, %



Direct R&D support
The OECD defines direct R&D support as the provision of research grants and payment for R&D services

Indirect R&D support
The OECD defines indirect R&D support as the provision of tax incentives, e.g. tax allowances, credits, deductions for R&D capex

Note:
Sample of 17 of 35 countries shown here.
Source: OECD R&D Tax Incentives Indicators, based on 2013 OECD-NESTI data collection on tax incentives support for R&D expenditures and OECD, National Accounts and Main Science and Technology Indicators, 15 December 2014; AlphaBeta/McKinsey analysis

4.3.6 Service-enhanced manufacturing

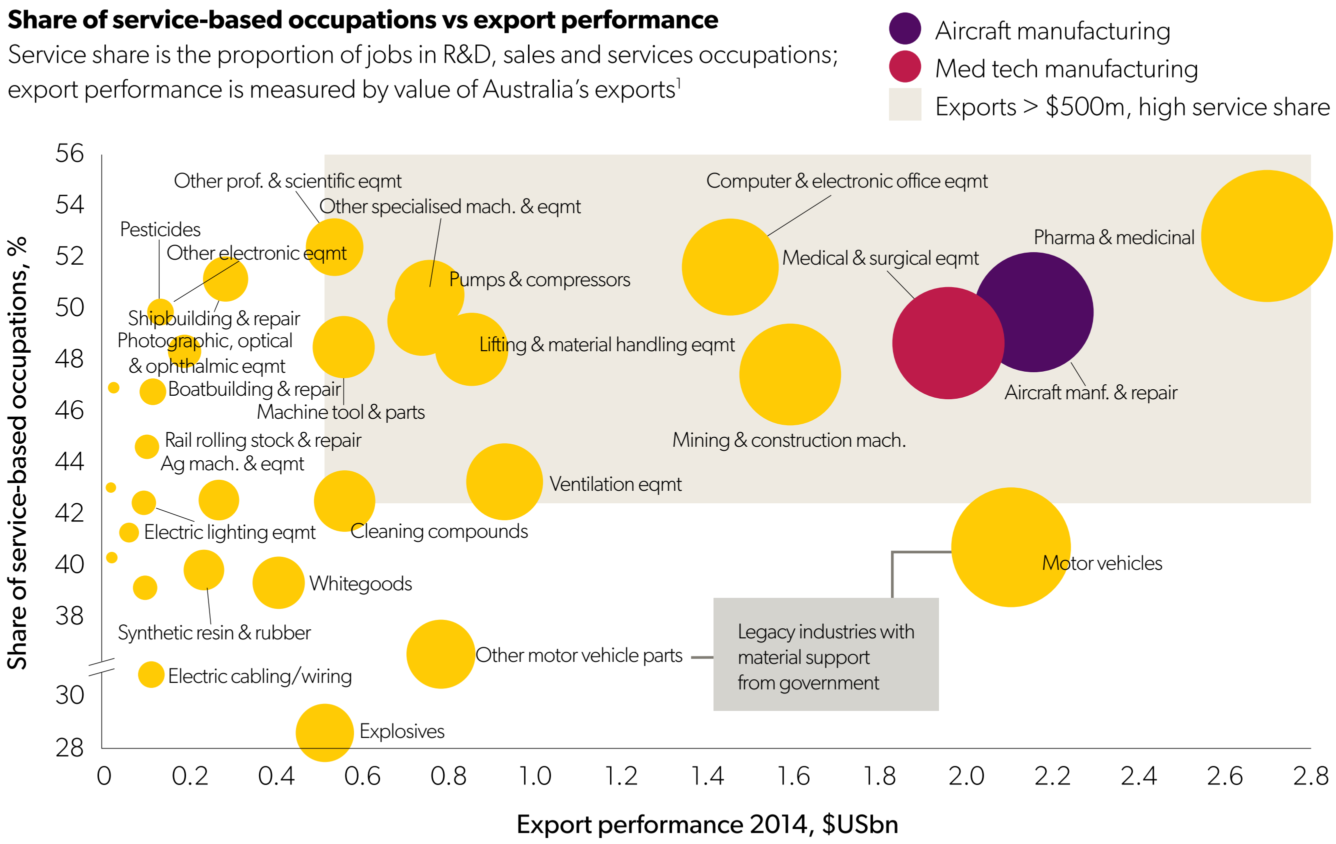
Another way to increase the competitiveness of Australian manufacturing is to provide customers with value-adding services associated with manufactured goods. The term 'servitisation' refers to the provision of services to clients by manufacturing firms.[51] These services typically support or complement products and help manufacturers to establish long-term relationships with consumers. The shift towards servitisation involves the restructuring of sales to focus on customer needs – for example, providing a capability or solution rather than selling a piece of equipment. It can also mean bundling services that are typically conducted by the customer or third parties in the outbound supply chain – for example, training, support, repairs, data monitoring and analytics. For example in aerospace, Rolls-Royce has moved to offer its customers 'power by the hour' – monitoring engines remotely, conducting repairs, and providing training and support to local engineers. The company recently reported that 49% of its revenue is derived from services. The upshot of servitisation is that it reduces the impact of high production costs by elevating the need for new skill sets in customer engagement, ICT, data management and analytics. It also encourages the customer to explicitly consider the lifetime benefit of the combined product–service offering.

Australia's strength in service delivery and highly skilled workforce make the nation well placed to increase the share of non-production activity such as design, engineering, sales and value-added services. Australian manufacturing has enjoyed export success where firms have transitioned to service-enhanced manufacturing. Exhibit 24 suggests that, apart from legacy industries that have received material support from the government, such as the automotive industry, the sub-industries that have the highest share of non-production occupations have exhibited the strongest export performance.[52]

51 Visnjic, I. and Van Looy, B. (2012), *Servitization: Disentangling the Impact of Service Business Model Innovation on Manufacturing Firms Performance*, ESADE Business School Research Paper, No. 230. Available at: http://proxymy.esade.edu/gd/facultybio/publicos/1393004444807Servitization_Disentangling_the_impact_of_service_business_model_innovation_on_the_performance_of_manufacturing.pdf

52 AlphaBeta/McKinsey analysis based on data from UN Comtrade, Australian Bureau of Statistics.

Exhibit 25 – Australian manufacturing industries that have created non-production capabilities exhibit the strongest export performance



1. 42 sub-industries defined by the ABS as an interim definition for advanced manufacturing.

Note: Bubbles represent size of Australia's exports. The chart draws correlation between share of services and export performance but not a causal relationship.

Source: UN Comtrade; ABS. AlphaBeta/McKinsey analysis

Likewise, some sub-industries are making the transition to a service-enhanced manufacturing model faster than others. Jobs growth in medical technology, for example, is occurring fastest in non-production roles such as design (45% growth from 2006–11), sales (40% growth) and services (26% growth). By contrast, in aerospace, employment is declining fastest in service-based occupations such as design, sales and after-market services (see Exhibit 26).[53]

Compared to the US, Australia is relatively weak in R&D and design jobs in aerospace, but on par in medical technology (see Exhibit 25).[54] Likewise, Australian medical technology is transitioning more quickly to service-based occupations than in the US. However, in aerospace, Australia is losing jobs in these parts of the value chain faster than the US (see Exhibit 27).[55]

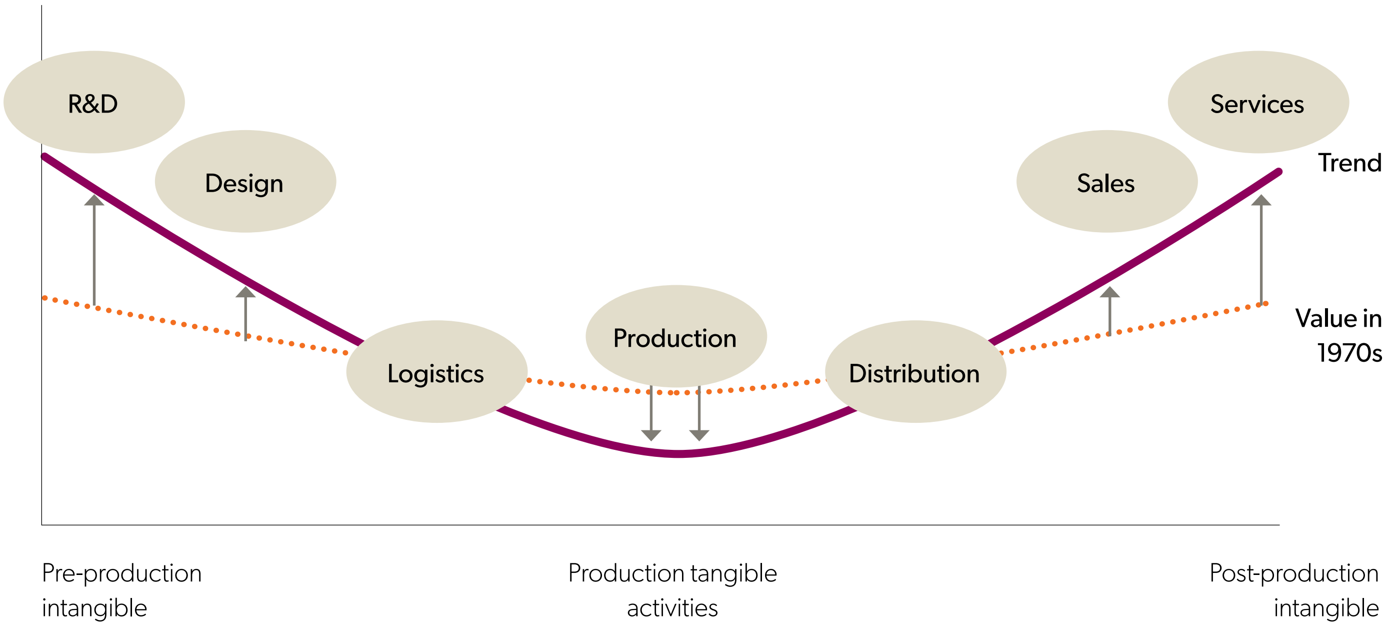
53 Australian Census (2006 and 2011). Calculated by portioning employment at 4-digit occupation level to the 4-digit industry.

54 Curve adapted from: 'Interconnected economies benefiting from global value chains', OECD 2013; data for estimation calculation drawn from ABS Census (2011); US BLS (2014); calculated by allocating occupations to different parts of value chain at the 4-digit occupation level. AlphaBeta/McKinsey analysis.

55 Australian Census (2006 and 2011), US Industry-Occupation matrix, by industry (2011), calculated by portioning employment at 4-digit occupation level to the 4-digit industry. AlphaBeta/McKinsey analysis. Job loss in aerospace in both the US and Australia is in part due to the life cycle of the industry being related to demand cycles from Tier 1 companies.

Exhibit 26 – Compared to the US, Australian manufacturing is relatively weak in R&D/design in aerospace but stronger in medical technology

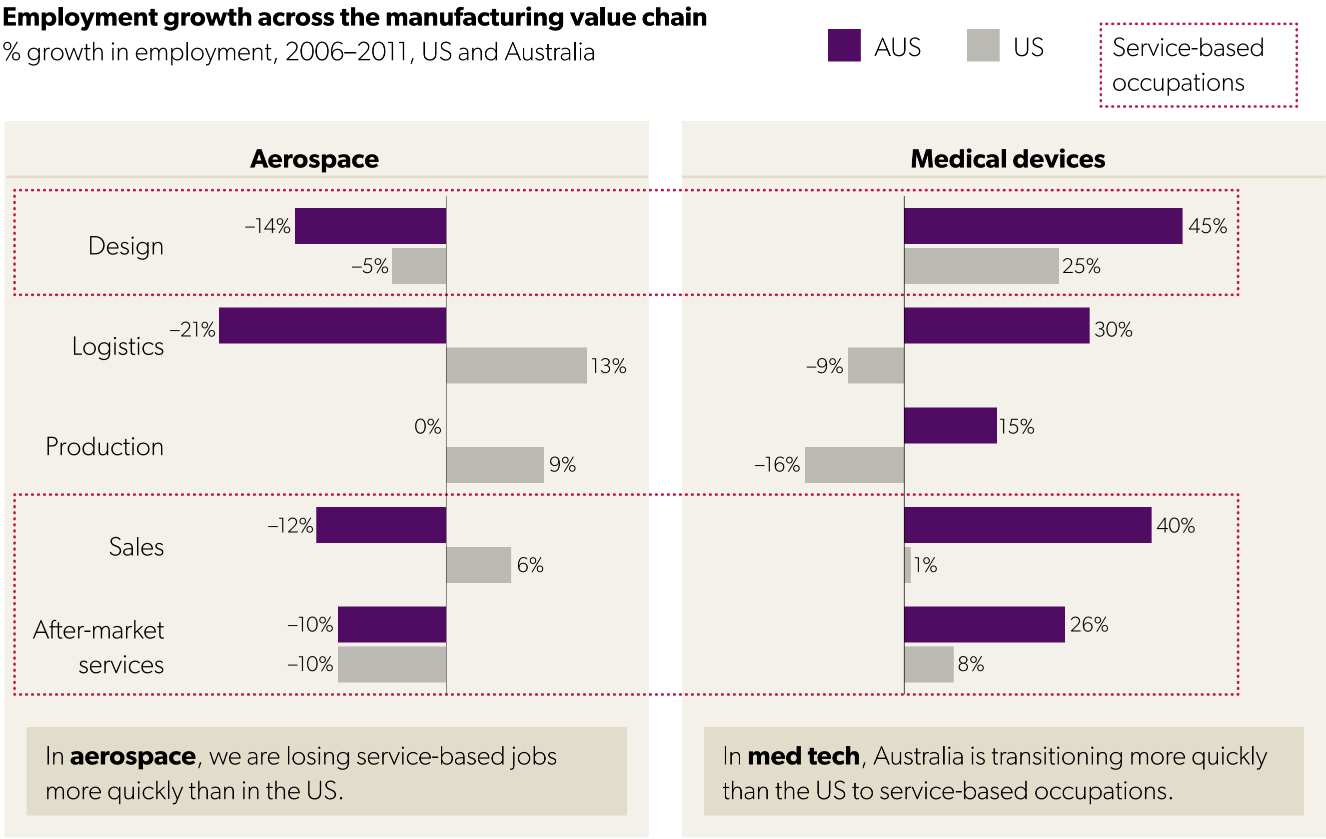
Value added, illustrative



Proportion of jobs along value chain, % total industry (estimated), 2011						
	Design	**Logistics**	**Production**	**Distribution**	**Sales**	**Services**
Aerospace						
AUS	8%	4%	36%	4%	9%	38%[1]
US	13%	7%	46%	8%	6%	20%
Med Tech						
AUS	9%	5%	41%	15%	15%	25%
US	7%	6%	48%	7%	13%	18%

1 High share of services in aerospace due to local maintenance and repair of Australian domestic fleets and low levels of domestic production.
Source: Curve adapted from: 'Interconnected economies benefiting from global value chains', OECD 2013; Data for estimation drawn from ABS Census (2011); US BLS (2014); Calculated by allocating occupations to parts of the value chain at 4-digit occupation level; AlphaBeta/McKinsey analysis

Exhibit 27 – In Australia, med tech is transitioning to service-based occupations more quickly than the US, but aerospace lags behind the US



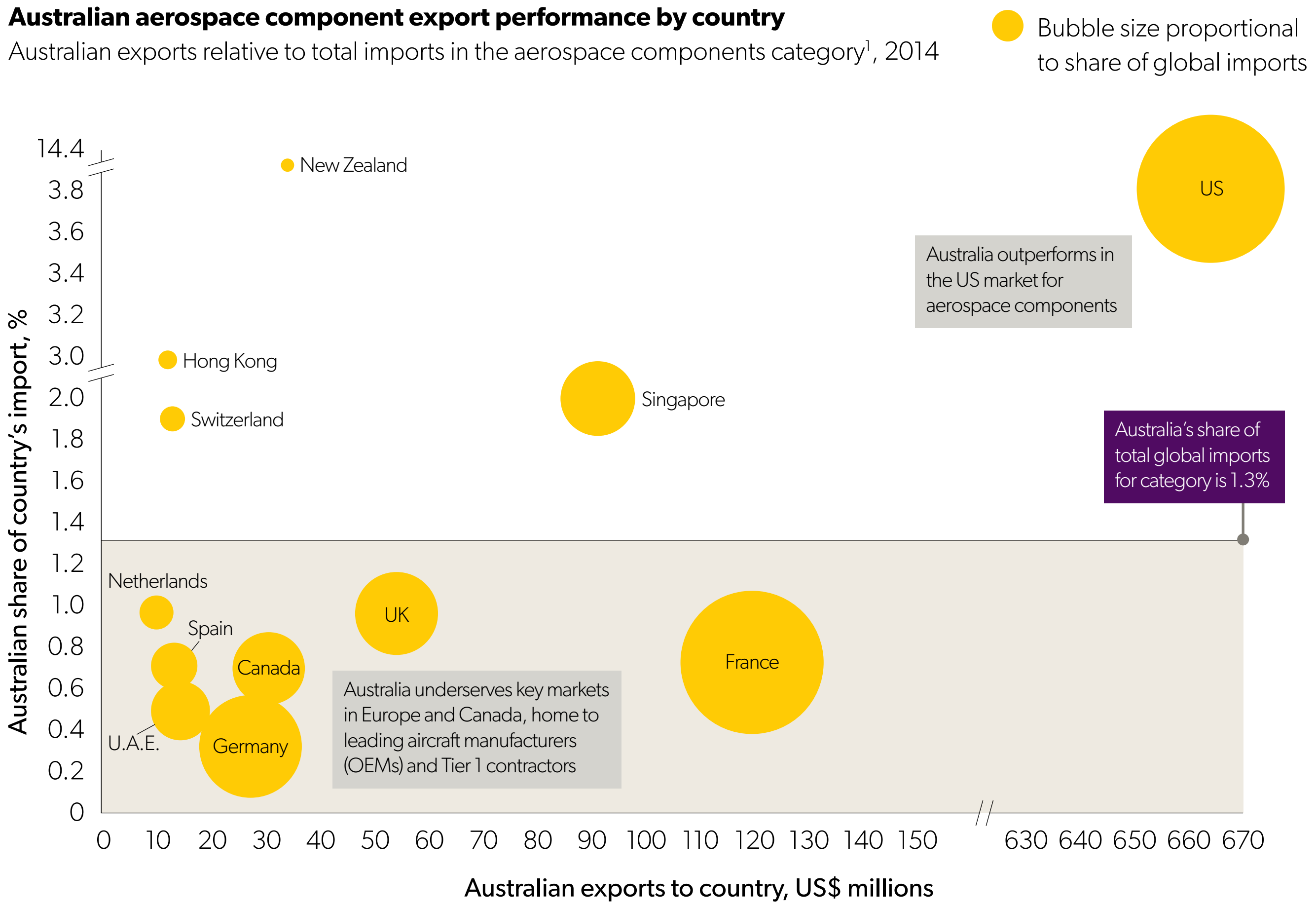
Source: Australian Census (2006 and 2011). US Industry-Occupation matrix, by industry (2011). Calculated by portioning employment at 4-digit occupation level to the 4 digit industry. AlphaBeta/McKinsey analysis

4.4 LIFTING COMPETITIVENESS BY SHIFTING MARKET FOCUS

4.4.1 Current export orientation

The third dimension of manufacturing competitiveness relates less to 'how' manufacturers compete and more to 'where' they compete. Australian manufacturers must focus on high-potential export markets, including markets for intermediate goods, if they are to strive. The importance of export ambition and orientation to the sustainability of manufacturing is well established. Empirical evidence demonstrates that productivity, profitability and wage benefits accrue to firms that export either directly or indirectly via suppliers to exporters.[56] AMGC's analysis of the export markets of Australian aerospace and medical technology manufacturing companies indicates success in export market development. It also highlights some areas where Australia is underperforming.

Exhibit 28 – Australian aerospace component exports to the US are strong, but underperform in the key OEM markets of Europe and Canada



1 'Components' includes parts for aeroplanes, helicopters, spacecraft or spacecraft launch vehicles, corresponding to HS category 8803.
Source: UN Comtrade. AlphaBeta/McKinsey analysis

56 OECD and World Bank Group (2015), *Inclusive Global Value Chains: Policy options in trade and complementary areas for GVC Integration by small and medium enterprises and low-income developing countries*, p. 14. Available at: <http://www.oecd.org/tad/tradedev/OECD-WBG-g20-gvc-report-2015.pdf>

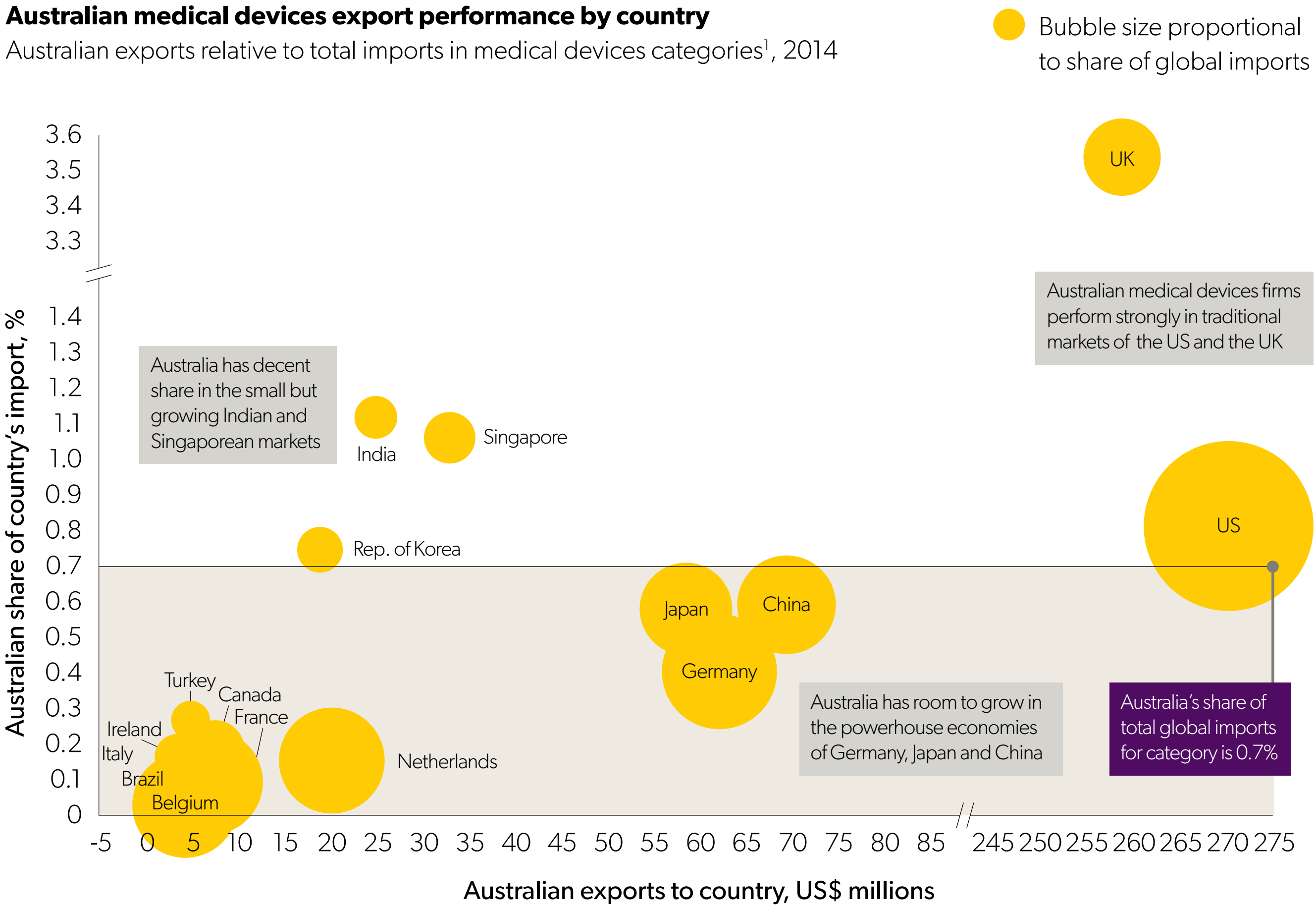
In aerospace, Australian exports of aircraft components to the US are very strong. However, its exports to key markets in Europe and Canada are underweight (relative to Australia's total share of global imports in aerospace of 1.3%), as shown in Exhibit 27. Some of this is for historic reasons. For example, after Boeing acquired Hawker de Havilland, it stopped selling components to Airbus. Notwithstanding, these markets represent key leading aircraft manufacturing hubs (or original equipment manufacturers) and Tier 1 contractors. They should be viewed as highly untapped opportunities for Australian firms.

In medical technology, Australia's exports to the UK and the US are strong, as shown in Exhibit 28, with a reasonable share in the small but growing Indian and Singaporean markets. However, Australia's exports to the powerhouse markets of Germany, Japan and China are underweight, relative to the nation's total share of global imports in medical technology of 0.7%.[57] The other key driver of market access is the gradual removal of trade barriers. For example, China's tariff on hearing aids and implantable medical devices has been removed under the China-Australia Free Trade Agreement.[58] Taking advantage of these opportunities to grow as further trade liberalisation occurs is vital to claim a growing share in emerging markets.

Exhibit 29 – Australian medical devices exports are still heavily skewed to traditional UK and US markets, with room to grow in Japan, Germany and China

Australian medical devices export performance by country

Australian exports relative to total imports in medical devices categories[1], 2014



1 Medical devices here defined as HS categories 9018 (instruments used in medical, surgical dental or vet. Sciences), 9020 (breathing apparatus), 9021 (orthopedics, implants, hearing aids) and 9022 (X-ray apparatus).

Source: UN Comtrade. AlphaBeta/McKinsey analysis

57 UN Comtrade. AlphaBeta/McKinsey analysis.

58 Department of Foreign Affairs and Trade (2016), China-Australia Free Trade Agreement Fact Sheet, Canberra. Available at: <http://dfat.gov.au/trade/agreements/chafta/fact-sheets/Documents/fact-sheet-investment.pdf>

4.4.2 Linking with global value chains

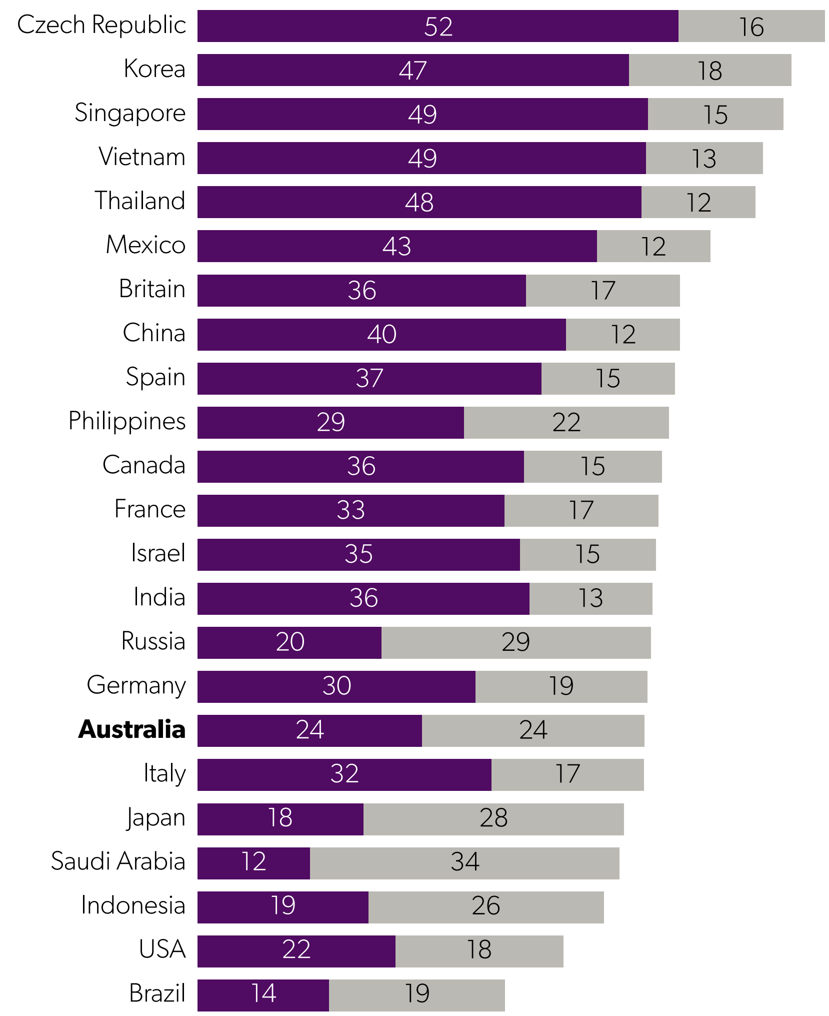
Manufacturing is increasingly occurring across global value chains, where the different functions of design, production, marketing and services occur across different countries. Analysis of Australia's backward and forward linkages help illuminate the extent of the nation's integration into global value chains. Backward linkages denote the use of foreign inputs to produce goods and services for export. Forward linkages denote the export of domestically produced goods or services to global companies further downstream.

Australia has among the weakest backward linkages of any major economy (see Exhibit 30). This suggests Australian manufacturers are missing opportunities to reduce costs, to drive innovation through the transformation of inputs, and to sell into new markets. As the OECD and World Bank have observed, imports play an important role in the economic activity of a country by "making available 'world-class' inputs and capital goods … and providing incentives for firms to innovate as they adopt knowledge, ideas, know-how and best practices from abroad".[59]

Exhibit 30 – Australian manufacturing is weakly engaged in global manufacturing value chains, especially with low use of foreign inputs in our exports

Global value chain (GVC) participation in manufacturing

Backward: % of foreign value added in exports; Forward: % of domestic value added in foreign exports, 2011



Backward GVC Linkage
This reflects the extent to which foreign inputs are used in creating Australia's exports

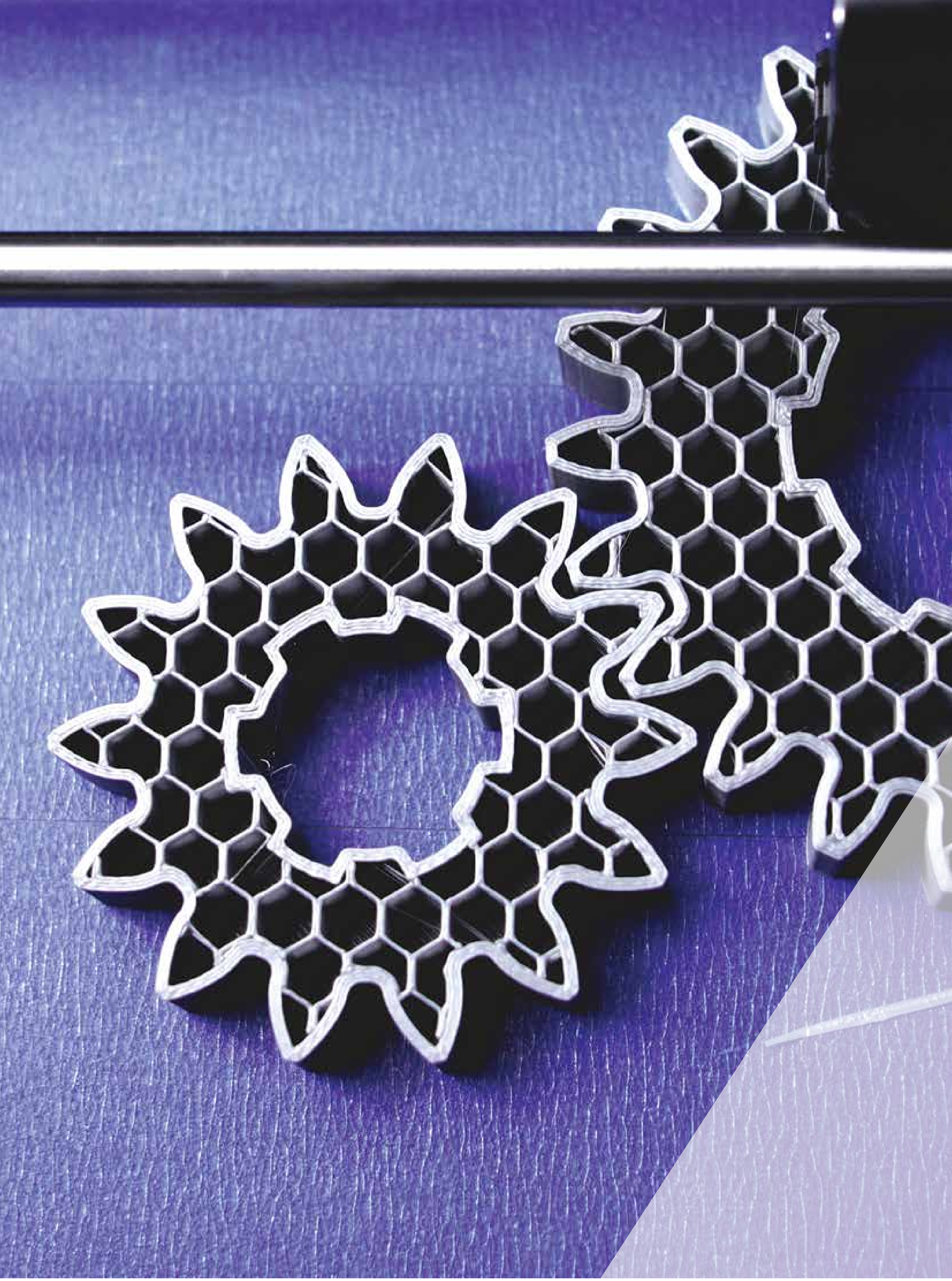
Forward GVC Linkage
This reflects the extent to which exports are used by other countries as an intermediary product in their exports

Australia's participation in GVCs is measured as the percentage point sum of forward and backward linkages.

Australia's low ranking is because it has among the weakest 'backward linkage' of economies globally.

Source: UN Comtrade (2014). AlphaBeta/McKinsey analysis

59 OECD and World Bank Group (2015), *Inclusive Global Value Chains: Policy options in trade and complementary areas for GVC Integration by small and medium enterprises and low-income developing countries*, p. 15. Available at: <http://www.oecd.org/tad/tradedev/OECD-WBG-g20-gvc-report-2015.pdf>



> Every Australian manufacturer has the potential to compete internationally, this will require an industry-led transformation.

5 ACTION PLAN FOR MANUFACTURING

5 ACTION PLAN FOR MANUFACTURING

5.1 OVERVIEW

AMGC's analysis in Sections 3 and 4 shows that every Australian manufacturer has the potential to compete internationally. This will require an industry-led transformation focused around four objectives:

- Increasing technical leadership to improve value differentiation
- Increasing value-adding services to improve value differentiation
- Improving market focus by identifying under-served segments and linking into global value chains
- Lifting scale and management capability to improve competitiveness.

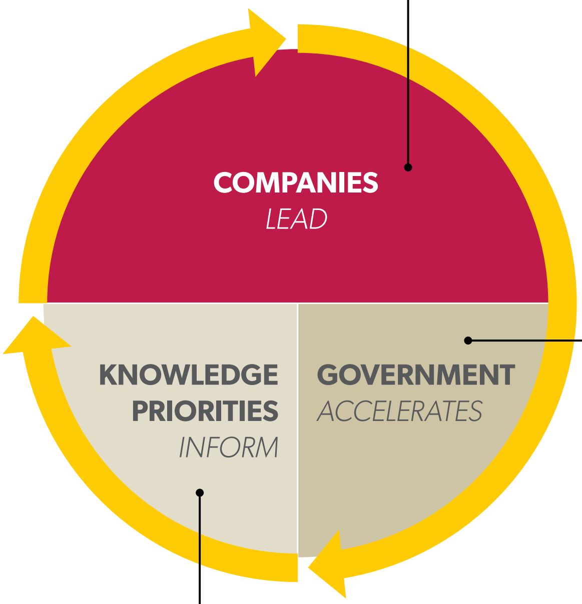
Moving beyond competitiveness to ensure long-term performance will require Australian manufacturers to also improve their resilience. This is best achieved by pursuing strategies to enhance firm and product superiority and diversity, as well as to ensure flexible business structures. The Australian Government can accelerate the transition through reforms such as improving support for business-led R&D, pursuing smarter procurement and altering the way manufacturing and progress in manufacturing is measured. With respect to bolstering resilience, the Government should seek to expand advisor expertise, better target funding and increase proactive connections between firms, R&D institutions and multinational corporations. Regular renewal of Australian manufacturing Knowledge Priorities will also set a direction for future progress.

In this section, AMGC details an action plan to create a thriving advanced manufacturing industry in Australia (see Exhibit 31). Companies need to lead the transition through a series of actions, (see Exhibit 32), supported by the Government (see Exhibit 33).[60] The section also includes key Knowledge Priorities relating to both R&D and business improvement that have been developed in consultation with industry.

60 Many actions will support multiple objectives. For example, increasing skill intensity helps to improve technical leadership (which increases value differentiation) as well as how efficiently the business is run (which will help to reduce product cost per unit). The actions also have differing effects on a company's revenue, costs and cost per unit, which determine the overall impact of an action on profitability. For example, increasing skill intensity may increase costs; however, revenue and cost per unit should improve.

Exhibit 31 – Companies must lead the transition to competing on value, supported by government and informed by Knowledge Priorities

Objective: Australian manufacturers need to compete through product and service differentiation, and better target export markets



Companies will lead the transition by:

- Increasing technical leadership
- Increasing value-adding services
- Improving market focus by reaching untapped markets and integrating into global value chains
- Lifting scale and management quality.

Many Australian businesses are already making this transition.

Government can accelerate the transition to new value-based business models by:

- Optimising support for business-led R&D
- Using smarter defence and civil procurement
- Designing assistance to target 'more advanced' characteristics
- Changing measurement of manufacturing.

Knowledge Priorities will inform and fuel the transition by:

- Identifying R&D Priorities: e.g. robotics, advanced materials and composites, digital design and rapid prototyping
- Identifying Business Improvement Priorities: e.g. workforce skills requirements, management capability, building international linkages and driving Industry 4.0 uptake.

Source: Competitiveness analysis

Exhibit 32 – Companies must lead the transition with a series of actions

4 objectives ...

- **A** Increase technical leadership
- **B** Increase servitisation
- **C** Improve market focus
- **D** Increase scale and management

... jointly supported by 8 actions	Objectives	Firm-level impacts: REVENUE	COST	COST PER UNIT
Increase business-led R&D	A D	↑	↑	↓
Increase skill intensity	A B D	↑	↑	↑
Collaborate with researchers	A D	↑	↑	↓
Develop service offers	B D	↑	↑	↑
Reach untapped markets and segments	B C	↑	↑	↓
Integrate into global value chains	C	↑	↑	↓
Improve management capability	A B D	↑	↓	↓
Collaborate to 'play bigger'	C D	↑	↓	↓

Source: Competitiveness analysis

Exhibit 33 – Government supporting actions and knowledge priorities can accelerate the transformation by supporting these company actions

What companies must do to transform		What government and research can do to support change				
		Government supporting actions			Knowledge priorities	
		Improve support for business-led research	Pursue smarter procurement and smarter programs	Change measurement of manufacturing	R&D knowledge gaps	Business improvement and knowledge gaps
Increase technical leadership	Increase business-led R&D	✓	✓	✓	✓	
	Increase skill intensity	✓	✓	✓	✓	✓
Increase servitisation	Collaborate with researchers	✓				
	Develop service offerings		✓	✓		✓
Improve market focus	Reach untapped markets and segments		✓			✓
	Integrate into global value chains		✓			✓
Increase scale & management	Improve management capability					✓
	Collaborate to 'play bigger'		✓		✓	

Source: Competitiveness analysis

5.2 ACTIONS FOR INDUSTRY

5.2.1 Increase technical leadership of Australian manufacturing

Australian manufacturing's strongest opportunity to succeed on a global scale is to differentiate through outstanding technical leadership. In order to offer unique products that provide customers with unparalleled value, Australian manufacturing firms should prioritise:

- **Lifting business-led R&D:** This is a core driver of long-term success in manufacturing firms. As outlined in Section 3, global manufacturing companies in the top 25% for productivity, compared with the bottom 25%, exhibit 3.17 times higher R&D intensity and 1.75 times the number of patents. However, as discussed in Section 4.3.3, Australian business expenditure on R&D as a proportion of GDP is well below many key OECD competitors. There is a clear opportunity for Australian manufacturers to increase expenditure on R&D, supported by actions by government.

VALUE DIFFERENTIATION

ResMed

Company background

ResMed is a medical technology company founded in Australia that has captured approximately 40% of the global market for sleep-aid devices. It employs more than 5,000 employees globally, with manufacturing facilities in Australia, France, Singapore and the US.

Product and service differentiation

In addition to personal products treating sleep apnea, ResMed has developed testing and data collection services such as ApneaLink Air and myAir which helps doctors and patients track the progress of sleep problems. The company's products and treatment options heavily integrate sensors and monitoring technology so that treatment can be monitored in real time. For example, its sleep lab titration system is able to relay information in real time between its testing and treatment devices. The company invested over $114 million in R&D during 2015, and has acted to acquire new expertise when necessary, including the purchase in January 2016 of Inova Labs Inc, which provides innovative oxygen therapy products.

Source: Company websites; press search, analysis of Compustat data, expert and industry interviews

- **Capitalising on Australia's cost advantage in high-skill labour:** Australian manufacturers have a substantial opportunity to increase the share of people with higher skills in their organisation, further driving their ability to achieve technical leadership. Section 4 identified how some Australian manufacturing sub-industries employ workers with a lower education mix compared with their international counterparts. However, a workforce with greater levels of formal training and qualifications is indispensable in advancing manufacturing. AMGC's stakeholder consultations repeatedly highlighted the value derived from investing in a highly skilled workforce.In addition to hiring tertiary-educated staff on a permanent basis, companies could consider hiring interns on scholarships. This strategy was used by a mining equipment manufacturer, whose manager reported: "Two scholarship students were brought on board to automate a key process. Even though it required knowledge outside of their specialty, their aptitude and ability to learn allowed us to get done in-house what would have cost us three times as much to outsource."[61]
- **Collaborating with research institutions:** As outlined in Section 4.3.4, Australian manufacturers need to improve their collaboration with researchers in order to develop technical leadership.[62] This requires effort by both parties. Research by McKinsey & Company into the organisational health of Australian firms found that they performed particularly poorly on building networks of external partnerships and on enabling collaboration and knowledge sharing.[63] Nonetheless, collaboration can work, and there are great examples internationally and in Australia. These include the collaboration between MDB and the University of Sheffield in the UK to develop cutting- edge titanium machining processes to win work on the Boeing 787. Another good example is the partnership between Deakin University and Quickstep to develop advanced carbon fibre manufacturing techniques (see Exhibit 34). By engaging proactively on priority projects and investing to support research, even with international universities, Australian firms can help ensure they are exposed to the latest global ideas.

61 AMGC (August 2016), industry consultation.

62 Department of Industry (2016), R&D Tax Incentive Review Issues Paper, Canberra. Available at: <https://www.business.gov.au/~/media/Business/RDTI/Review/Research-and-Development-Tax-Incentive-Issues-Paper-PDF.ashx?la=en>

63 Aggregate analysis of more than 18,000 individual Australian responses to McKinsey's Organisational Health Index (OHI): Lydon, J. et al. (2014), Compete to Prosper: Improving Australia's global competitiveness, McKinsey & Company. Available at: <http://www.mckinsey.com/global-locations/pacific/australia/en/latest-thinking/compete-to-prosper>

Exhibit 34 – Many global firms have achieved success in advanced manufacturing through industry collaboration and through industry-university collaboration

Aerospace example collaborations	Overview	Key aspects of approach
1 United Launch Alliance	**Industry–Industry:** A 50–50 joint venture between Lockheed-Martin and The Boeing Company for space launch systems	• Joint venture between two previously staunch competitors • Recognising high-costs and scale effects in space launch, formed joint venture to significantly reduce costs • Regulators approved the joint venture subject to conditions protecting launch access for small satellite manufacturers
2 Marand/BAE/ Quickstep	**Industry–Industry:** Marand, BAE Australia and Quickstep collaborating to produce ~700 F–35 vertical tail sets	• Marand won contract for ~700 F–35 vertical tails with BAE Systems Plc (UK), sub-contracting titanium components to BAE Australia and carbon fibre components to Quickstep • BAE Systems collaborating with Australian companies on qualification processes
3 MDB & the University of Sheffield	**Industry–University:** MDB and the University of Sheffield collaboration on advanced titanium manufacturing processes to win 787 landing gear work	• MDB engineers and researchers from Sheffield's Advanced Manufacturing Research Centre worked together to develop advanced titanium machining processes. • This enabled increased use of titanium in main landing gear systems, a weight-saving performance feature, and led to winning the 787 contract for main and nose landing gear
4 Deakin Carbon Nexus and Quickstep	**Industry–University:** Deakin University and Quickstep collaboration on advanced carbon fibre manufacturing processes	• Quickstep has established its automotive division and global R&D centre on Deakin's Geelong campus, associated with Deakin's Carbon Nexus facility, which brings together 11 industry partners from nine countries • Geelong Region Innovation and Investment Fund provided $1.76 million to establish the automotive division at Deakin

Source: Company websites; *Wall Street Journal*; *Australian Defence Magazine*; UK Government (2012) 'Lifting off: implementing the strategic vision for UK aerospace'; Deakin University; ARC website

- **Closing the deficit in management quality in order to improve productivity and reduce cost:** Australia has fewer high-performing managers than other successful countries. Specifically, research by the London School of Economics showed that just 4.7% of Australian firms received a high management grade, compared with 15.5% of firms in the US and 8.0% of firms in Germany.[64] Accordingly, there is an opportunity for Australian manufacturers to address the management quality deficit. On the positive side, efforts to increase skill intensity have been proven to improve the management capability of Australian manufacturers.[65] Later, this *Manufacturing Competitiveness Plan* details further investigation that is required to understand the drivers of the management capability gap (see Section 5.4.3).

5.2.2 Increase value-adding services within Australian manufacturing

There is a significant opportunity for Australian manufacturers to transition into higher-value service offerings. AMGC's analysis in Section 2 revealed that some of Australia's advanced manufacturers are increasing roles in R&D, engineering design, and sales and service more quickly than others. To accelerate the transition to services, Australian manufacturers should:

- **Develop compelling service offerings that complement Australia's comparative advantages:** In order for industry to transition to higher-value segments, firms need to develop compelling service offerings that complement products, accelerate their uptake of new manufacturing techniques and secure the talent pipeline. This requires changes to culture, skill mix, and contracting and financing arrangements. Some Australian firms have already transitioned to service differentiation, including MiniFAB and Textron Systems Australia.

VALUE DIFFERENTIATION

miniFAB™
MICRO-ENGINEERING / MEDICAL / MANUFACTURING

Company background

Micro-engineering firm miniFAB produces predominantly medical device solutions, along with food packaging and aerospace products. miniFAB was established in 2002 and now has offices in Europe and the US along with clients worldwide.

Product and service differentiation

miniFAB's services span the length of the value chain, from design and prototyping through to manufacture, assembly and supply chain logistics. The company relies on providing highly customised solutions, working with clients to select the right materials, design and processing solutions. miniFAB has to date worked on over 900 projects.

Source: Company websites; press search, analysis of Compustat data, expert and industry interviews

64 See for example, Green, R. & Roos, G. (2012), 'Australia's Manufacturing Future: Discussion paper', prepared for the Prime Minister's Manufacturing Taskforce, Sydney. Available at: <https://www.uts.edu.au/sites/default/files/Australia's_Manufacturing_Future.pdf>

65 ibid.

VALUE DIFFERENTIATION

TEXTRON

Company background

Textron Systems Australia is an aerospace company with 50 employees and annual revenue of $5 million to $10 million. It produces small unmanned aircraft for military and civilian use, but adopts a business model that also proactively sells support services.

Service differentiation

The company differentiates on service offering in a number of ways. First, its Support Solutions business provides operational support to keep assets functioning, and includes personnel who are directly embedded with their clients worldwide to support their missions. Second, the company offers supply chain management and logistics support which helps the customer track assets, reduce the cost of storage and ownership, and engage in obsolescence planning. Third, the service offering also includes a flight operations business which uses its own unmanned aerial vehicles.

Source: Company websites; press search, analysis of Compustat data, expert and industry interviews

- **Lifting skill intensity, particularly in service-oriented roles:** Jobs within service-enhanced and increasingly digitised manufacturing will increasingly require higher educational levels. As one international study noted, "the evidence on the future demand for skills in manufacturing suggests that over the period to 2020 more people, proportionately, will be employed in jobs where a degree is required to gain entry".[66] The shift into greater provision of services will require firms to demand skills related to customer engagement, ICT, data management and analytics. Many of the relevant tertiary qualifications will involve STEM subject matter.[67] Analysis in Section 4.3.3 revealed that Australian firms are not currently employing a sufficient share of high-skill workers. In order to attract these candidates, companies may need to take steps to improve the attractiveness of manufacturing. This includes showcasing careers as part of courses and connecting with education providers to offer experiential or activity-based learning (including internships, placements and short project-based assignments). In addition, the industry needs to do more to boost the perception of manufacturing among younger people, in order to influence their career choices and opportunities on offer.
- **Partner with the education system to foster work-ready skills:** The servitisation of manufacturing will also likely require improved readiness among graduates to deploy work-ready skills. The Productivity Commission recently attributed current rates of MEST under-employment post-graduation to the lack of readiness among graduates to use problem-solving skills in technology-rich work environments.[68] Changes to teaching methods that develop problem-solving skills such as experiential, project-based or employer-connected learning are considered most likely to develop work-ready skills. Later, this *Manufacturing Competitiveness Plan* details actions for AMGC to showcase examples of servitisation and to map which parts of the industry have made this transition, using data from job ads (see Section 6.4).

66 UK Government Office for Science (2013), 'What type of future workforce will the UK need?'. Available at: www.gov.uk/government/uploads/system/uploads/attachment_data/file/283910/ep36-manufacturing-future-workforce.pdf

67 ibid.

68 Australian Government. Productivity Commission (2016), 'Digital Disruption: What do governments need to do?' Available at: http://www.pc.gov.au/research/completed/digital-disruption/digital-disruption-research-paper.pdf

5.2.3 Improve market focus

> The most important thing we can do is be nimble, because we know we need to follow the customer and give them what they want but are not yet getting.
>
> **Industry participant**, AMGC consultation[69]

Top-performing firms globally exhibit a high level of integration into export markets. They also offer products with a high value density (with the top 25% of firms exhibiting a value density 1.09 times the bottom-performing firms). To compete on the world stage, Australian manufacturing firms will need to set high aspirations to enter new markets and deliver new products and services that offer meaningfully better performance for their customers. One clear message from stakeholder engagement is that Australia's successful exporters were either 'born global' – with export ambitions from day one – or at some point made a very deliberate choice to enter new markets or transform their capabilities. Improving Australian manufacturing's market focus will require action to:

- **Identify and reach untapped markets and segments:** Australian manufacturers are underweight in a number of key export markets, including for intermediate goods. Companies can work further with Austrade and other assistance programs or international business chambers to identify their under-served markets and develop strategies for market entry. With regard to niche markets and segments, Australian manufacturers can increase their overall competitiveness by focusing on those products and markets that naturally play to the nation's high-skill workforce and cost advantage in high-skill workers. Australian companies can also create a competitive edge by identifying niche markets that they are well-suited to serve (for example, through a highly customised or specialised offering or by finding an under-served market). Some Australian companies, such as Codan, have improved their market focus and found market niches. Later, this *Manufacturing Competitiveness Plan* proposes actions for Austrade to identify under-served markets, including for intermediate goods, by sub-industry (see Section 6.4).

MARKET FOCUS

CODAN

Company background

Codan designs and manufactures electronic products predominantly for the telecommunication and mining sectors. The company has been in operation for over 50 years and has customers in 150 countries.

Market focus

The company engages in global value chain analysis to identify key markets or sectors in which it could offer a comparative advantage. It is then able to cater to these markets with customised design and off-the-shelf products or through outsourcing. Over 90% of Codan's revenue is derived from exports, a fact which reflects the success of Codan's strategy in integrating itself into various global value chains. To maintain cost competitiveness while maximising its advantages, the company produces its low-volume, high-value products in the Australian markets, while outsourcing its high-volume, low-complexity products to an outsourced facility in Malaysia.

Source: Company websites; press search, analysis of Compustat data, expert and industry interviews

69 See for example: Department of Innovation, Industry, Science and Research (2009), *Management Matters in Australia*. Available at: http://worldmanagementsurvey.org/wp-content/images/2010/07/Report_Management-Matters-in-Australia-just-how-productive-are-we.pdf

- **Link into global value chains:** As noted in Section 3, Australia is poorly connected into global value chains, with among the weakest backward linkages of any major economy. In order to reduce product costs and improve value differentiation, companies could use a higher proportion of foreign inputs in their goods and services produced for export.

5.2.4 Lift scale and management quality

While few Australian firms achieve global success by trying to compete on cost alone, there are several opportunities for Australian manufacturing to improve its cost position. These include:

- **Increasing company size to improve capability to deliver complex systems:** This will require collaboration and potentially consolidation within the industry, as well as collaboration with research institutions. As noted in Section 4.2.3, Australian manufacturers may struggle to make substantial investments in capital intensity, in part due to their disproportionately smaller size. In smaller firms, overheads are not spread across large volumes, and shorter production runs make it harder to optimise production. These scale challenges can be mitigated by collaboration, at least partially. This includes by pooling R&D resources or capital investments. AMGC's collaboration hubs represent a mechanism to facilitate the sharing of resources and capabilities between firms that operate in certain geographical areas and are part of similar value chains. To date, hubs are operating in Geelong and Clayton in Victoria.
- **Investing in higher capital intensity, newer equipment and higher rates of automation:** Top global manufacturing firms exhibit high levels of advanced processes, which aim to drive process reliability and quality, as well as cost efficiency and competitiveness. As outlined in Section 4, global companies in the top 25% for productivity, compared with the bottom 25%, exhibit 1.61 times the capital efficiency, 1.50 times newer equipment, 1.30 the rate of automation, and 1.25 times higher energy and water efficiency.
- **Improving management quality to lift productivity and reduce cost:** Australia has a lower share of high-performing managers than other successful countries. Improving management quality will require proactive investment in the workforce and continued investment in management training and skills. Management skills can be understood as a mix of operations management (adopting lean manufacturing processes), performance management (clear and effective goal-setting), and talent management (incentivising top performance, as well as sustaining innovative workplace cultures and a strong talent mindset).[70] As well as improving technical leadership, as discussed in the previous section, stronger management also supports efficiency and productivity.

5.2.5 Improve resilience to ensure long term performance

As discussed in Section 3, Australian manufacturers must be resilient as well as competitive in order to ensure their longer-term performance. Australian manufacturing is highly volatile. Even successful manufacturing companies can lose their advantage when their industry enters a period of contraction or if customer tastes change. To bolster resilience, Australian manufacturing firms need to:

- **Build superiority**: firms should collaborate with research institutions, invest in R&D; develop services bundled with major projects to ensure their products cannot be substituted in the event of an industry contraction; and build workforce skills.
- **Build diversity**: firms should identify diverse export markets; integrate products into multiple global supply chains; and identify new customers within existing product segment industries to minimise reliance and exposure to a single industry, market or customer.
- **Build flexibility:** firms should build collaborative agreements with suppliers to allow for cost flexibility; access cash and liquid assets to provide working capital in downturns; use customisable or modular production techniques; and flexibly deploy their workforces to serve clients across different industries.

70 See, for example, Department of Innovation, Industry, Science and Research (2009), *Management Matters in Australia*. Available at: <http://worldmanagementsurvey.org/wp-content/images/2010/07/Report_Management-Matters-in-Australia-just-how-productive-are-we.pdf>

5.3 ACTIONS FOR GOVERNMENT

5.3.1 Support for R&D and industry-research collaboration

Support for R&D and research collaboration has long underpinned Australia's export successes. This is particularly the case in industries that rely on advances in science and technology as their drivers of innovation. For more firms to develop technical leadership, the Australian Government must encourage business-led R&D and greater collaboration with research institutions. This need not involve additional funding; instead, it requires a redesign of current government support for business-led R&D. Furthermore, with tighter leadership, collaboration and alignment between industry and universities, Australia's strong research pipeline will better translate to commercial outcomes.

Proposed action:
Improve the design of Australian Government support for business-led R&D

Government support for business-led R&D is not optimally designed to achieve different R&D objectives. Section 4 outlined a number of R&D objectives that governments seeks to achieve, including: (1) encouraging investment by firms in R&D with different risk profiles (i.e. both medium and higher risk) and different time horizons (i.e. both short- and longer-term); (2) ensuring that minimal government funding is provided to R&D activity that is infra-marginal (i.e. to investment that would have occurred without the incentive).

In order to best achieve these objectives, the Australian Government should reduce support for infra-marginal activity and boost support for both medium-risk, short-term R&D through the Tax Incentive. It should also support higher-risk, longer-term R&D through more direct forms of grant assistance. In order to achieve these objectives, the Government should (see Exhibit 35):

- **Tighten eligibility criteria to reduce support for infra-marginal business-led R&D:** While acknowledging the challenge of targeting additionality through a volume-based scheme, the recent Review of the R&D Tax Incentive sensibly recommended the introduction of an intensity requirement to better target larger companies' access to the scheme.[71] AMGC strongly supports this recommendation.
- **Consider using the savings generated from tightened eligibility criteria to encourage investment by firms in R&D with different risk profiles and time horizons:** In order to encourage medium-risk or shorter-term business-led R&D, the Government could continue funding under the R&D Tax Incentive but simplify application processes to encourage take-up. The Review of the R&D Tax Incentive sensibly recommended a single application process rather than the current separation of registration and claims.[72] As outlined in Section 2, Australia is an outlier in the proportion of government support for business-led R&D that is provided via indirect rather than direct channels. In order to encourage higher-risk or longer-term business-led R&D, which often carries high spillover benefits, the Government should consider shifting the mix of government support for business-led R&D away from indirect channels (see Exhibit 36). There are successful examples of direct R&D funding in many countries (see Exhibit 36). For example, the US SBIR program provides grants to small businesses in two phases, without matched funding requirements: small grants for feasibility and proof-of-concept work to "establish the technical merit, feasibility and commercial potential of the proposed R&D effort". It also offers larger R&D grants for projects shown to have high potential.[73] Other examples of direct funding organisations include Japan's NEDO, which provides targeted grants for translational research in areas that can 'enhance Japan's competitiveness'.[74] Singapore's NRF possesses a grant portfolio which includes proof-of-concept grants for business.

71 Finkel, Ferris, Fraser (2016), *Review of the R&D Tax Incentive*.

72 Ibid.

73 See small business innovation research by the US Department of Health and Human Services, National Institutes of Health. Available at: www.sbir.nih.gov

74 For example, investment by NEDO has facilitated the growth of the solar power industry in Japan: Yamashita, M. et al. (2013), *Impact evaluation of Japanese public investments to overcome market failure: Review of the Top 50 NEDO Inside Products*, Research Evaluation, Vol. 10, No. 13, Available at: < http://www.nedo.go.jp/content/100799089.pdf>

5 ACTION PLAN FOR MANUFACTURING

Exhibit 35 – Government support for business-led R&D could be modified to better enable achievement of different R&D objectives

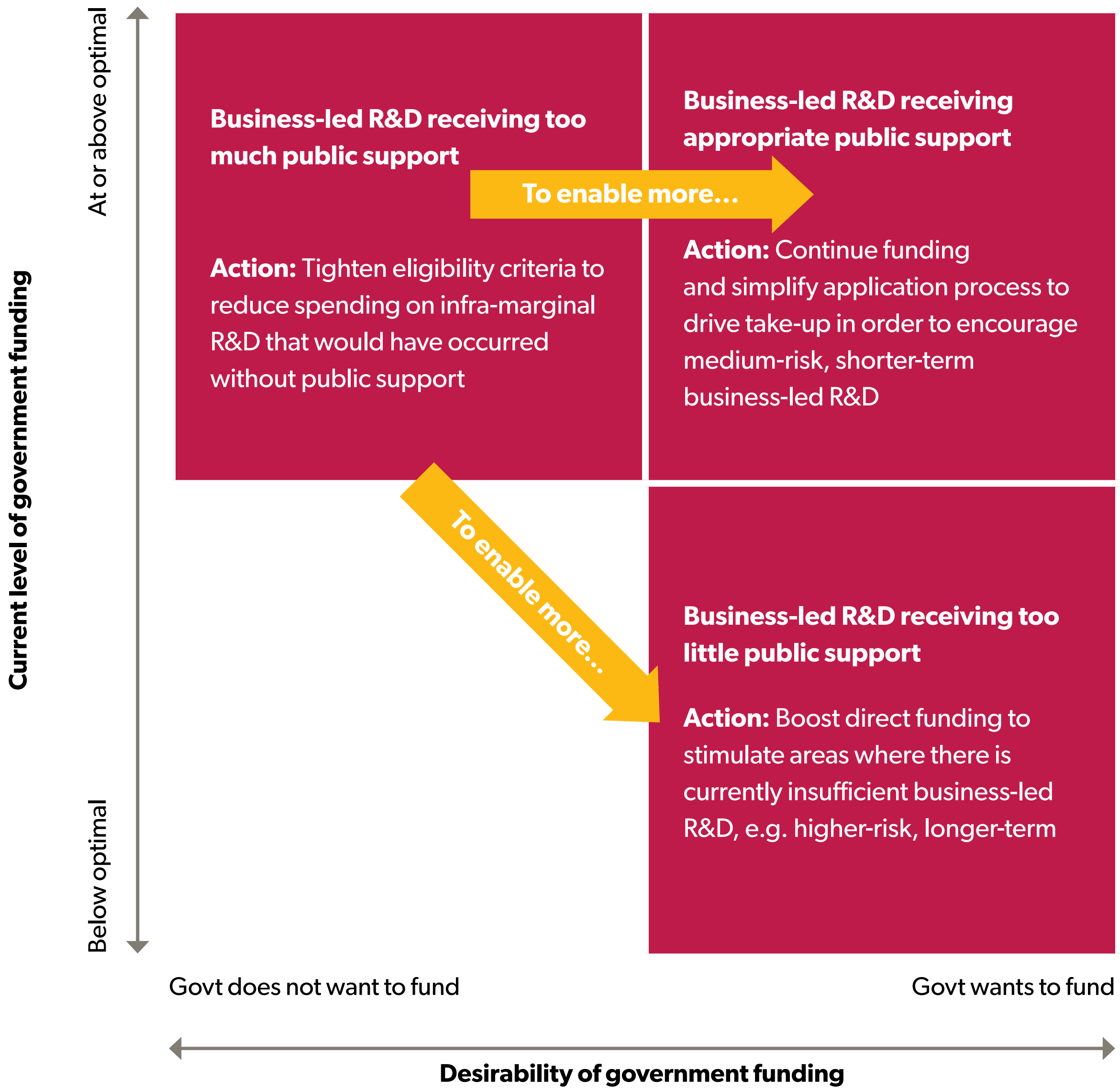
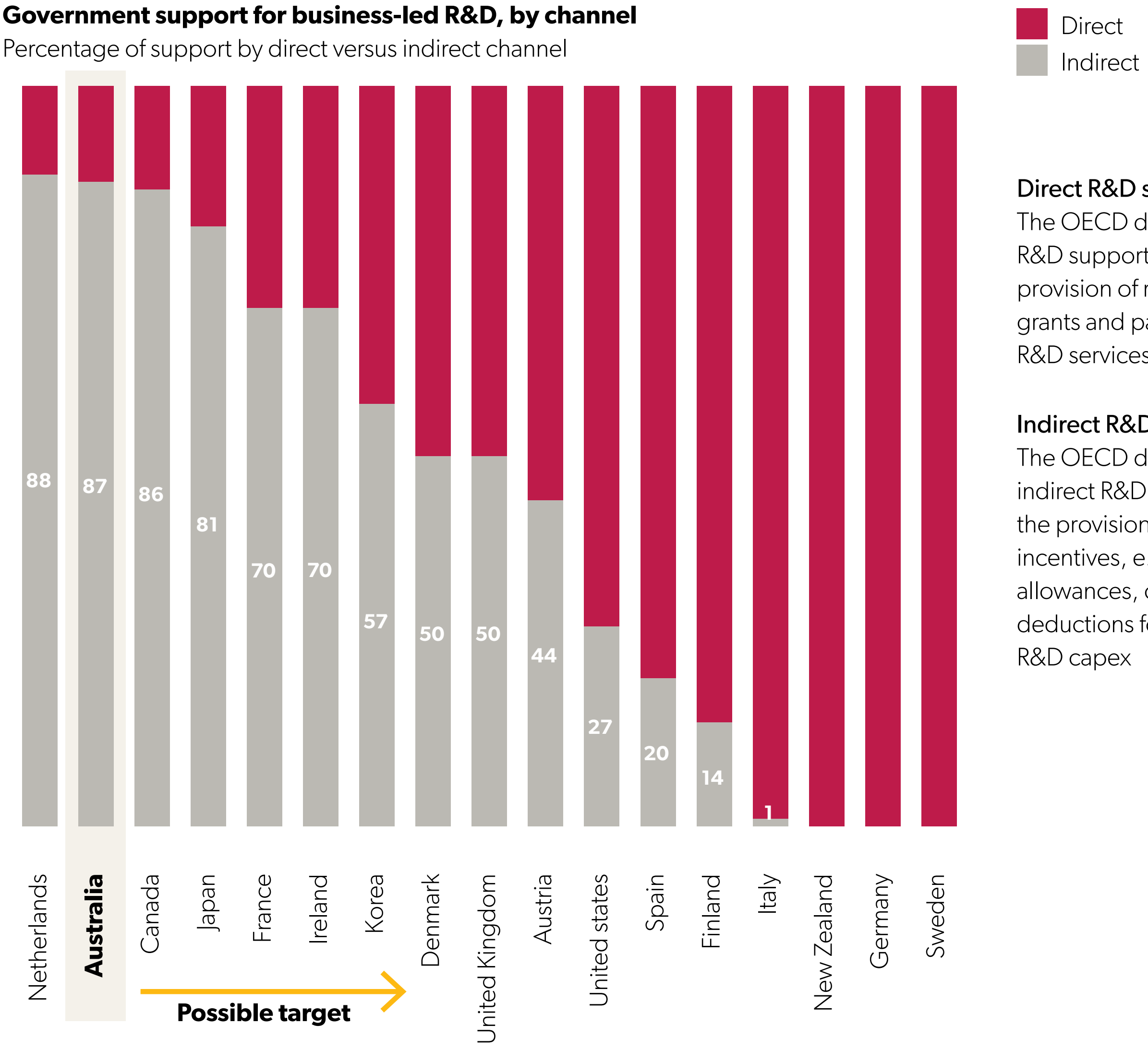


Exhibit 36 – Australiashould shift to a higher proportion of direct R&D funding so as to improve policy impact and correct Australia as an outlier

Government support for business-led R&D, by channel

Percentage of support by direct versus indirect channel



Direct R&D support

The OECD defines direct R&D support as the provision of research grants and payment for R&D services

Indirect R&D support

The OECD defines indirect R&D support as the provision of tax incentives, e.g. tax allowances, credits, deductions for R&D capex

Note:
Sample of 17 of 35 countries shown here.
Source: OECD R&D Tax Incentives Indicators, based on 2013 OECD-NESTI data collection on tax incentives support for R&D expenditures and OECD, National Accounts and Main Science and Technology Indicators, 15 December 2014; AlphaBeta/McKinsey analysis

Exhibit 37 – Direct funding approaches are used around the world to drive innovative R&D

Example organisations	Overview	Key aspects of approach
US Advanced Research Projects Agency – Energy	The Advanced Research Projects Agency – Energy is the US Government's R&D investment agency for early-stage transformational technologies in energy	• Funds projects too early for investment from the public sector, through grants or cooperative agreements (greater scope for supervision/intervention), with tangible deliverables agreed for quarterly milestones • Focuses on a limited number of priority areas, with individual projects vetted by a panel including subject matter experts
Japan New Energy and Industry Technology Development Organisation	Japan's New Energy and Industrial Technology Development Organisation funds research in energy and industrial technology	• Explicit commitment to 'enhancing Japan's industrial competitiveness' • Focused on translational research (TRL4-6) in areas set through examination of trends and expert consultation, such as fuel cells, robot technology, power electronics and energy conservation
Singapore National Research Foundation	Singapore's National Research Foundation supports investments to create new industries and enable growth	• Focus on economic impact, with four priority areas 'where Singapore has competitive advantages and/or important national needs': advanced manufacturing, health and biomedicine, urban solutions and sustainability, and services and digital economy • Grant mechanisms include proof-of-concept grants for researchers to develop commercialisable prototypes and a technology incubation scheme (co-investment)
US Defense Advanced Research Projects Agency	The US Defense Advanced Research Projects Agency pursues breakthrough technologies for national security	• Invests across the spectrum of technological readiness from scientific investigation to integration in systems, explicitly pursuing high-risk, high-reward projects • Focus areas determined on an ongoing basis through a) program managers looking for areas with revolutionary potential, and b) requests from the military

Source: ARPA-E website; ARPA-E budget; DARPA website; BusinessWeek; NRF website and reports; NEDO website and report

Proposed action: Encourage greater collaboration between research and industry

Australia must improve its rate of collaboration between the researchers and industry to drive technical leadership among manufacturers. Improving the alignment between public research and commercial opportunity should also be a priority.[75] There are many potential mechanisms including providing greater incentives for researchers who collaborate[76], and to build collaboration requirements into existing government assistance for R&D, including business-led R&D.[77]

With regard to incentives and recognition, one approach is to ensure that researchers who collaborate with industry are recognised professionally, with industry impact included in key metrics for performance evaluation. As highlighted by the Academy of Technological Sciences and Engineering, current incentives in Australia result in a focus on research excellence, "often at the expense of [...] university collaborations with the private and public sectors, entrepreneurial behaviour and knowledge transfer". As such, it is essential that "research engagement is appropriately recognised and rewarded alongside research excellence".[78]

The new engagement and impact metric currently being developed by the Australian Research Council may help to promote collaboration under the Excellence in Research for Australia evaluation process[79], or explicitly recognise commercialisation outcomes in sector rankings.[80]

With regard to collaboration requirements, existing government support for R&D, including business-led R&D, can be redesigned to require collaboration. For example, government could increase industry-wide research funding opportunities which incentivise collaboration design, such as the Australian Government's investment in National ICT Australia (NICTA), now Data61 at CSIRO.[81] Or, as the recent Review of the R&D Tax Incentive recommended, a collaboration premium could "provide additional support for the collaborative element of R&D expenditures undertaken with publicly funded research organisations."[82] This recommendation aims to lift the current rate of collaboration under the Tax Incentive, with only 9.5% of registered projects indicating collaboration with another organisation in 2013–14.[83]

75 Department of Industry (2016), R&D Tax Incentive Review Issues Paper, Canberra. Available at: <https://www.business.gov.au/~/media/Business/RDTI/Review/Research-and-Development-Tax-Incentive-Issues-Paper-PDF.ashx?la=en>

76 Bell, J. et al. (2015), Translating research for economic and social benefit: country comparisons, ACOLA, Melbourne. Available at: http://acola.org.au/PDF/SAF09/SAF09%20Full%20report.pdf. In addition to improving formal collaboration, the creation of informal spaces for 'integrative thinking' is regarded a key ingredient for increased innovation. See, for example, Green, R. & Roos, G. (2012), Australia's Manufacturing Future: Discussion paper prepared for the Prime Minister's Manufacturing Taskforce, Sydney.
Available at: https://www.uts.edu.au/sites/default/files/Australia%27s_Manufacturing_Future.pdf

77 In addition to improving formal collaboration, the creation of informal spaces for 'integrative thinking' has been noted as a key ingredient for increased innovation. See, for example, Green, R. & Roos, G. (2012), Australia's Manufacturing Future: Discussion paper prepared for the Prime Minister's Manufacturing Taskforce, Sydney. Available at: <https://www.uts.edu.au/sites/default/files/Australia's_Manufacturing_Future.pdf>

78 Bell, J. et al. (2015), *Translating research for economic and social benefit: country comparisons,* ACOLA, Melbourne. Available at: <http://acola.org.au/PDF/SAF09/SAF09%20Full%20report.pdf>

79 Academy of Technological Sciences and Engineering (2015), *Research engagement for Australia. Measuring research engagement between universities and end users.* Available at: https://www.atse.org.au/Documents/reports/research-engagement-australia.pdf

80 McKeon, S. et al. (2013), Strategic Review of Health and Medical Research, DCRC & CHeBA, University of New South Wales, NSW. Available at: <https://cheba.unsw.edu.au/sites/default/files/presentations/McKeon%20SRHMR_130603%20(2).pdf>

81 Stanford, J. (2016), *Manufacturing (Still) Matters: Why the Decline of Australian Manufacturing is NOT inevitable, and What Government Can Do About It.* Australia Institute. Available at: <http://www.tai.org.au/content/manufacturing-still-matters>

82 Ferris, Finkel, Fraser (2016), *Review of the R&D Tax Incentive.*

83 Department of Industry (2016), *R&D Tax Incentive Review Issues Paper*, Canberra. Available at: <https://www.business.gov.au/~/media/Business/RDTI/Review/Research-and-Development-Tax-Incentive-Issues-Paper-PDF.ashx?la=en>

5.3.2 Smarter procurement and programs

Proposed action:
Use smarter civil and defence procurement to drive innovation, collaboration and export focus

Australian Federal and state governments have the opportunity to leverage both their defence and civil procurements to drive innovation and collaboration between firms, and to create opportunities for Australian firms in global supply chains. They can channel spending to stimulate greater domestic demand. They can also and craft procurement requirements to enable firms to scale faster into niches where they can be globally competitive. To do this well, policy should focus on:

- **Driving technical leadership:** Innovation requirements should be established within procurement arrangements to drive technical leadership and ensure that the technology or product will be globally distinctive. This could be coupled with grants to help firms build capability and strengthen the domestic supply base, making it easier for global contractors to include Australian firms in their supply chains. For example, the New Air Combat Capability – Industry Support Program of the Department of Defence enabled Australian firms to win work in the supply chain of the F-35 fighter plane by providing customised grants to Australian companies to upskill in key capability areas.[84]
- **Targeting procurement support where Australia has a comparative advantage:** This should be via either current or forecast future capability, that could be developed to scale through guaranteed demand. Critically, support should not be provided to prop up industries that were once semi-competitive but are no longer viable. Government efforts to support industries without comparative advantage tend to fail. While it was delivered through a different mechanism, some of the assistance provided to the automotive assembly industry highlights the risks involved. In 2014, the Productivity Commission found that the costs of supporting the automotive industry outweighed the benefits.[85]
- **Ensuring export opportunities and global supply chain integration:** Government procurement can create opportunities for manufacturers to connect with global supply chains. As an example, Israeli defence procurement often seek to build local capacity to engage with global supply chains. This is done on the principle that projects should be of mutual benefit and result in long-term strategic joint ventures or alliances. The Israeli Government has helped create partnerships and entry points to the global supply chains of leading aerospace companies, resulting in inbound investment in excess of the original mandate.[86] A clear pitfall here is escalating procurement costs and compromising capability through excessive focus on Australian content. AMGC believes that building domestic capability should be a secondary goal, pursued on a case-by-case basis and targeted where it affects Australia's interests. Industry participation schemes that have focused on import substitution for its own sake tend to make domestic firms *less competitive* due to the explicit protection afforded.

84 Department of Defence, New Air Combat Capability – Industry Support Program, Canberra. Available at: <http://www.defence.gov.au/dmo/DoingBusiness/Industry/IndustryPrograms/JSF-ISP/>; AlphaBeta/McKinsey interviews with industry experts.

85 Australian Government. Productivity Commission (2014), *Australia's Automotive Manufacturing Industry – Inquiry report*. Available at: www.pc.gov.au/inquiries/completed/automotive/report

86 A AIDN (2014), *Industry Involvement for Defence in Australia*, Melbourne. Available at: www.aidn.org.au/documents/aidn%20australian%20industry%20involvement%20paper%20-%20may%202014.pdf

- **Collaboration opportunities:** Australia has few strategic procurement programs to help companies develop scale in niche areas, particularly compared to other developed countries.[87] When government organisations in Australia have used strategic procurement, they have tended to focus more on the perceived value of final assembly. As an example, during a recent defence aircraft procurement negotiation, the government initially pushed for final assembly to occur in Australia even though it would have been difficult to achieve efficiency at low volumes and would have provided little benefit in terms of capability transfer. This push was despite the manufacturer's offer to invest in building local capability to maintain advanced systems throughout the life of the aircraft, which could have helped to build competitive scale in a high-skill field.
- **Limited reliance on targets:** Many countries have decided to set a target for the amount of mandated foreign assistance that is tied to procurement contracts. If a government chooses to do so, they would need to be confident the target was modest, initially realistic and would not create unintended consequences such as those described above. A good example is Israel's modest targets of 35–50%, which are regularly exceeded by ensuring that local firms participate meaningfully in global supply chains.[88] By contrast, Australian levels are currently closer to 5–10% in F-35 acquisition[89]. Any target would need to be initially set low and ratcheted up to enable time for industry to build capacity. This *Manufacturing Competitiveness Plan* outlines further actions by AMGC to tailor civil and defence procurement opportunities (see Section 6.4.2).

Proposed action:
Harness existing government assistance programs to drive advancement

Having uncovered the characteristics associated with successful and more advanced global manufacturing firms, federal and state government policy and programs can better target the promotion of these characteristics in Australian firms. Australian manufacturers have access to a suite of federal assistance, including the Entrepreneurs' Programme, the ARC Industry Transformation Research Programme, Austrade, the R&D Tax Incentives and CRCs. There are also numerous state-based industry assistance funds and capability-building or facilitation programs that help manufacturers or are available to manufacturing firms. Federal and State governments should work together to ensure these programs are best aligned to advance manufacturing.

Where assistance programs are capability-building in nature, these capabilities could be targeted towards building the characteristics associated with successful, more advanced firms. These include advanced knowledge (such as R&D intensity and wage levels), advanced process (such as capital intensity and automation levels) and advanced business models (such as share of services in revenue).

Where these programs offer incentives or support, the evaluation criteria could be oriented towards ensuring higher prevalence of key characteristics – for example, share of services in revenue, R&D intensity and capital intensity.

87 AIDN (2014), *Industry Involvement for Defence in Australia*, Melbourne. Available at: www.aidn.org.au/documents/aidn%20australian%20industry%20involvement%20paper%20-%20may%202014.pdf

88 AIDN, *op. cit.*

89 As of December 2015, Australian industry had won US$554.5 million in production and development contracts. See: Department of Defence (2016), 'F-35 Program Key Facts & Milestones'. With average costs of A$90 million per aircraft and orders for 72 aircraft, the total order is worth ~US$6.5 billion for direct acquisition alone. Australian industry currently has an ~8.5% share.

5.3.3 Measuring manufacturing progress

AMGC believes that the key measures of progress within Australian manufacturing should be whether firms are advancing, as well as the wider impact of manufacturing on the economy. Tracking these objectives will ensure that Australia keeps its eyes on the prize in manufacturing. Is the nation transitioning to sustainable, high value-added manufacturing and is it accurately capturing the impact that manufacturing has on other industries? Accordingly, the Australian Government should make three changes to the way that progress of the industry is currently measured (see Exhibit 38).

Proposed action:
Measure prevalence of key 'advanced' characteristics

Currently, progress in manufacturing is primarily measured by whether jobs, output and exports have increased for the subset of ANZSIC classes defined as 'advanced'. Rather than using these traditional metrics alone, AMGC recommends measuring whether or not the industry is advancing by tracking the prevalence of key characteristics associated with 'advancement' across all manufacturing sub-industries. Specifically, this could involve measuring whether there have been changes in skill mix; average level of qualifications or proportion of high qualifications; research and development intensity; patent/trademark portfolio; wage levels; capital efficiency; automation rates; collaboration rates; the value density of products; and the share of revenue represented by services. Most of these metrics are currently used as part of the ABS's Expanded Analytical Business Longitudinal Database. The exception is the share of revenue represented by services, which AMGC recommends be added to one of the existing survey formats such as the Business Characteristics Survey.

Proposed action:
Report modified versions of output and jobs growth

The Department of Industry, Science, Energy and Resources currently measures progress of the manufacturing industry primarily against employment, output and exports.[90] It reports progress against a number of characteristics-related metrics including innovation and business performance. These metrics are reported at the 1-digit level (for example, manufacturing) and for the sub-industries currently classified as 'advanced'.

AMGC recommends reporting modified versions of output and jobs growth at the 1-digit level of manufacturing. There are some challenges with traditional metrics such as output and employment, given the rate of servitisation and flexible sourcing of labour across the economy for services such as design, accounting, marketing and cleaning. However, where these jobs are directly linked to manufacturing activity, it is important to make the connection to manufacturing, albeit imprecisely, to ensure the true value of manufacturing to the economy is captured as accurately as possible. There are international examples of attempts to attribute output and employment to different industries. For example, in the US, the Bureau of Labor Statistics constructs annual employment tables for 168 sub-industries, which indicate the employment supported directly and indirectly per US$1 million of sales of goods and services to final users. The BLS also provides annual input–output tables, which show sales generated in a range of industries by demand from other industries. This makes it easier to identify the reallocation of output to upstream industries.[91] Accordingly, AMGC recommends reporting a modified version of output and jobs that captures the direct and indirect impact of manufacturing (see Exhibit 38).

90 As per international documents from the Department of Industry, including the advanced manufacturing data pack.
91 US Bureau of Labor Statistics. Available at: https://www.bls.gov/emp/data/input-output-matrix.htm

Even this modified reporting of employment is likely to understate the employment impact of manufacturing. The transitions occurring in the new economy mean that manufacturing activity may not appear in either the manufacturing codes or in input–output tables related to manufacturing. For example, in an era of digitally delivered textbooks, jobs in printing and distribution might be lost. However, new jobs in technology development, maintenance and support will emerge and not necessarily appear linked to manufacturing since manufacturing is a (horizontal) capability, cutting across every industry sector in which something is being made (vertical).

Proposed action: Measure 'spillover' benefits

In addition to the common metrics outlined above, AMGC recommends measuring the 'spillover' benefits of manufacturing, or its broader contribution in the economy. Specifically, given the important role of manufacturing in supporting innovation, productivity and exports[92], AMGC recommends tracking the share of R&D, productivity growth and total exports represented by the manufacturing industries.

Exhibit 38 – We recommend three changes to how the industry is measured

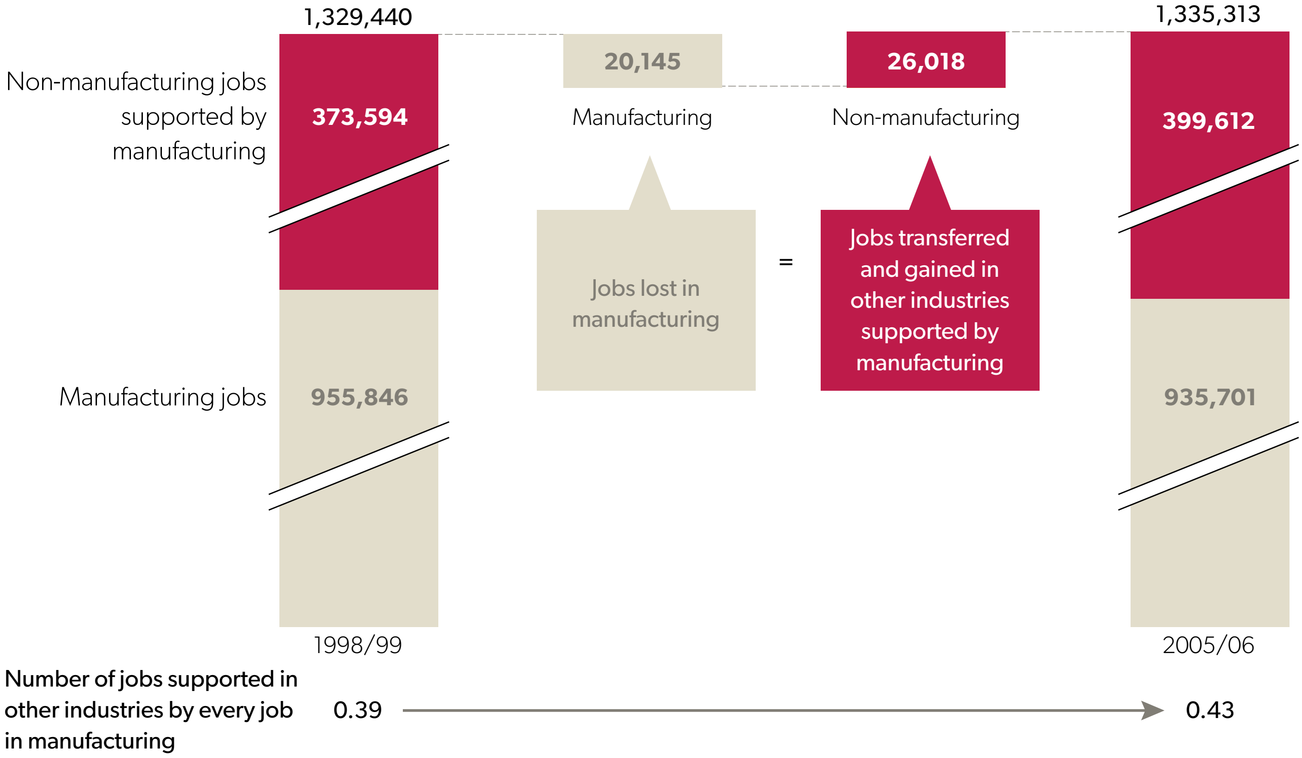
1. Measure the prevalence of key characteristics	2. Report modified versions of value-added and jobs growth	3. Measure 'spillover' benefits
Track 'advancement' of industry by the **prevalence of characteristics** associated with being more advanced such as: › Advanced knowledge: skills (by type); qualifications (by level); research and development intensity; patent/trademark portfolio; wage levels; collaboration (by type) › Advanced processes: capital efficiency; automation › Advanced business models: value density; share of services	**Report modified version of key metrics of interest (e.g. value-added, jobs, exports) across the Growth Centres** including: › For 1-digit manufacturing › A modified version of value-added and jobs for 1-digit manufacturing, which captures the impact of manufacturing on other industries (see Slide 9) › For a set of firms found to be 'more advanced' according to prevalence of key characteristics › Establishing thresholds for characteristics in Year 1 that capture 50% of firms as 'more advanced' (e.g. overall advancement index of 1.2) › Aggregate incremental jobs growth of all firms in Year 2 that meet criteria (including new entrants and minus exits)	**Track 'spillover' benefits of manufacturing** or why manufacturing matters to wider economy such as: › Share of business expenditure on R&D › Share of total exports › Share of total productivity growth

92 For example, see https://d3n8a8pro7vhmx.cloudfront.net/theausinstitute/pages/536/attachments/original/1464819264/Manufacturing_Still_Matters___Centre_for_Future_Work.pdf?1464819264, pp. 4–6.

Exhibit 39 – Rethinking what manufacturing is and the way manufacturing is measured will help to better understand progress and the broader impact of manufacturing

Direct and indirect employment from Australian manufacturing

Number of jobs



Note: Non-manufacturing jobs supported by manufacturing are calculated from IO tables and employment/value added ratios. The period selected (1998/9 to 2005/6) deliberately excludes the global financial crisis and automotive industry decline.

5.3.4 Improve existing programs that support resilience

A range of Australian Government programs provide vital support to manufacturing firms. These include advice on start-up and growth, innovation funding, and connections to research institutes to enhance R&D. Many of these programs indirectly support resilience. Nonetheless, there is more that can and should be done – both to support firms and enhance the value for money for government, ensuring that the firms supported through these programs survive periods of volatility.

Proposed action:
Expand advisor expertise

- AMGC recommends ensuring that advisors who provide support to Australian manufacturers through a range of initiatives, in particular the Entrepreneurs Programme, understand manufacturing and the key drivers of resilience to assess and advise businesses accordingly.

Proposed action:
Better target funding

- AMGC recommends reviewing criteria to ensure that funding is targeted, where appropriate, towards initiatives that will help businesses expand into new geographical markets or develop technologically superior products.

Proposed action:
Increase proactive connections

- AMGC recommends that funding be increased for support services that increase the number and quality of R&D connections and better connect Australian SMEs with multinational corporations. This could involve providing local companies with information about cross-industry and cross-border opportunities.

5.4 KNOWLEDGE PRIORITIES

5.4.1 Overview

The industry-led transition to advance manufacturing can be further guided and informed by investigation of key Knowledge Priorities. Developing and disseminating knowledge is vital to help Australian manufacturing differentiate itself on value and technical leadership. AMGC has identified two types of Knowledge Priorities that will need to be addressed to enhance the competitiveness of the Australian manufacturing industry:

- R&D priorities – these are technological and scientific gaps in Australia that can help to improve manufacturing processes or drive product innovation.
- Business improvement priorities – these are analytical priorities aimed at better understanding business capability gaps and the best ways to overcome them.
- The Knowledge Priorities outlined in this section are the product of AMGC's competitiveness analysis, a review of the existing literature, and comprehensive industry engagement including a survey with more than 50 respondents from companies, industry associations, government bodies and research organisations.[93] Annex B provides further detail on the methodology used to identify the priorities.

5.4.2 R&D priorities

Australian manufacturing businesses, industry associations and the research community have identified several R&D priorities to help Australian manufacturing become globally competitive. These will help to increase technical leadership in products and expand associated value-adding services.[94]

93 Survey participants were asked to evaluate the relevance of the proposed priorities, identify additional priorities and offer further comment on the R&D and business improvement issues most affecting the industry. More than 50 organisations and companies responded to the survey.

94 The following list is ranked in order of importance and impact as identified by the survey and sources listed in the previous section. For greater detail on a number of these priorities, we recommend referencing the CSIRO's Industry Roadmap for Advanced Manufacturing.

Robotics and automated production processes

Robotics and automated production processes refer to the design and operation of robots in manufacturing[95], enabling greater productivity, lower costs, upskilling of workers, improved workplace safety and higher product quality. Examples of current knowledge gaps in Australia include:

- How can error detection and reduction rates be improved so that automated processes continue to provide a reliable output?
- How can advanced materials improve the functionality of robots and the enablement of 'soft robotics'?[96]
- How can robots better develop situational awareness (vision and sensors) to interact with workers and customers, and in controlled environments?
- How can software be improved to enable robots to communicate with each other, and other manufacturing equipment/processes?

Advanced materials and composites

Advanced materials and composites refer to new materials that are developed to provide superior performance across a variety of dimensions such as strength, weight and flexibility.[97] This enables greater product differentiation and customisation for manufacturers. Examples of knowledge gaps include:

- How can flow chemistry increase reproducibility, scale and safety?
- Are there new bonding techniques that can improve the speed of manufacturing and the resilience of existing materials and composites?
- What new materials exist at the molecular or nano scale that can herald new opportunities?
- How can materials that are flexible or self-healing better allow for remote repair?
- How can the development and application of wear-resistant materials be enhanced?

Digital design and rapid prototyping

Digital design and rapid prototyping refer to the product development cycles enabled by ICT visualisation and analytic tools[98]. Manufacturers enjoy lower product development costs and greater opportunities to customise products. Examples of knowledge gaps include:

- How can software platforms be improved to make it easier for Australian manufacturers to complete new product designs?
- What production processes or business services will allow increased rapid prototyping so manufacturers can create highly customised products?
- How can small-scale production become more cost-effective so smaller Australian manufacturers are able to viably engage in design-led production?

Sustainable manufacturing and life cycle engineering

Sustainable manufacturing and life cycle engineering refer to the development of products with lower energy consumption, improved durability or maintenance costs, and higher potential for recycling or collaborative consumption.[99] Sustainable manufacturing presents an opportunity to reduce costs and greater ability to meet eco-conscious market demand. Examples of knowledge gaps include:

- How can waste capture opportunities in the production cycle be identified and seized?
- How can new and existing recycling methods be expanded across more parts of the value chain, and to more industries?
- How can products and production processes be designed to maximise recycling opportunities?

95 CSIRO (2016), *Advanced manufacturing. A roadmap for unlocking future growth opportunities for Australia.* Available at: www.csiro.au/~/media/CABB4E555E7C4D4C986C4164FCC0214D.ashx

96 According to the IEEE Robotics & Automation Society, 'soft robotics' refers to the use of soft or deformable materials in robotics systems, enabling safer interaction with their environment and improved performance. See: http://softrobotics.org/basic-information/

97 CSIRO (2016), *Advanced manufacturing. A roadmap for unlocking future growth opportunities for Australia.* Available at: www.csiro.au/~/media/CABB4E555E7C4D4C986C4164FCC0214D.ashx

98 CEDA (April 2014), 'Advanced Manufacturing: Beyond the Production Line', <https://www.ceda.com.au/ResearchAndPolicies/Research/Economy/Advanced-Manufacturing-Beyond-the-production-line>; CSIRO (draft: October 2016), 'Future of the Australian Advanced Manufacturing Industry – An Industry Roadmap'.

99 CSIRO (2016), *Advanced manufacturing. A roadmap for unlocking future growth opportunities for Australia.* Available at: www.csiro.au/~/media/CABB4E555E7C4D4C986C4164FCC0214D.ashx.

Additive manufacturing

Additive manufacturing refers to the use of digital 3D design data to make a component by successively depositing layers of material, enabling mass customisation and on-site printing. Examples of knowledge gaps include:

- How can uniformity be improved in mass manufacturing using 3D printing processes?
- How can composites and dissimilar materials be manufactured reliably using additive techniques?
- What are effective ways to combine additive and subtractive processes?

Sensors and data analytics

Sensors and data analysis refer to the use of devices to monitor, control and diagnose issues with production lines in real time. This enables increased production volumes and reduced machine downtime.[100] Examples of knowledge gaps include:

- Can relevant sensors be embedded into more parts of the production process and final product, especially where this involves exposure to harsh operating environments?
- What kinds of battery and data storage solutions will be needed to make the use of sensors more widespread and viable?
- How can the analysis of data gathered from sensors be made more user-friendly for manufacturers as well as clients?
- How can sensors be made more self-powering, biodegradable, bio-compatible and wirelessly connective?
- How can IT systems increase data storage and security to handle higher capture and security threats?

Materials resilience and repair

Materials resilience and repair refers to the ability of a material under stress to absorb energy and return to its original state.[101] This enables product performance characteristics including strength, flexibility and durability. Examples of knowledge gaps include:

- How can material behaviour and complex processes such as flow chemistry be better modelled to increase material resilience?
- How can scanning or other methods be enhanced to better detect stress points and weaknesses in composite materials or assembled products?
- Are there new or substitute materials that can increase the resilience of a product line?

Bio-manufacturing and biological integration

Bio-manufacturing and biological integration refer to the use of biological systems to produce molecules that cannot be extracted or synthesised directly.[102] This enables the development of innovative products and materials. Examples of knowledge gaps include:

- Can more advanced resilient bio-degradable packaging solutions be found?
- What high-value compounds and new materials can be created by using biological instruments such as algae?
- How can biological processes, including the breakdown of materials for easy recycling, be incorporated into the production processes of traditional products?

100 CSIRO (2016), *Advanced manufacturing. A roadmap for unlocking future growth opportunities for Australia*. Available at: www.csiro.au/~/media/CABB4E555E7C4D4C986C4164FCC0214D.ashx.

101 White, M. A. (2011), Physical Properties of Materials, 2nd Edn, CRC Press; Princeton University Press, The *Properties of Materials*, Ch 1, <http://press.princeton.edu/chapters/s9638.pdf>

102 White House (April 2016), 'Advanced Manufacturing: A Snapshot of Priority Technology Areas Across the Federal Government'; Industry Canada (2006), 'The Canadian Biopharmaceutical Industry Technology Roadmap', <http://publications.gc.ca/collections/Collection/Iu44-31-2006E.pdf>

Nano-manufacturing, micro-manufacturing and precision manufacturing

Nano-manufacturing, micro-manufacturing and precision manufacturing refer to production that uses very small-scale components and materials, or applies high-precision tools[103] to improve product performance characteristics. This enables a high degree of product differentiation and opportunity for manufacturers to customise products. Examples of knowledge gaps include:

- How can the resilience and reliability of precision manufactured items be enhanced?
- What is required for the system-level integration of precision manufacturing innovations?
- What computational and modelling innovations will better enable precision manufacturing?

Augmented or virtual reality systems

Augmented or virtual reality systems refer to technology that engages workers with a computer-generated representation of the physical world. This enables remote control of machinery or guiding workers through on-site operations[104], and ultimately improves cost and safety outcomes. Examples of knowledge gaps include:

- How can augmented reality be used to allow closer human–machine interaction in the design and manufacturing of products, including through the use of advanced sensors?
- How can improved processing power, download size, resolution, frame rates and depth sensors allow for more complex visualisations?
- What kinds of wearable virtual reality technologies are best suited to manufacturers in different contexts – such as on the factory floor, exhibiting to a client, or in testing product use?
- How can the computability of software platforms be enhanced?

5.4.3 Business improvement priorities

AMGC's competitiveness analysis in Section 2 and its industry survey identified several areas where further investigation is required to understand business capability gaps and how to correct them.[105]

Drivers of the management capability gap

Australia has a long tail of manufacturing companies that perform poorly on management capability.[106] It also has a shortage of managers with higher qualifications. Examples of knowledge gaps include:

- How do different manufacturing sub-industries perform on management capability?
- How does management capability vary by firm size?
- What are the key drivers of management capability gaps?
- What are the most effective ways for Australian manufacturers, especially SMEs, to drive improvement in management capability?

Understanding workforce skills requirements

Understanding the strengths and weaknesses of the current Australian manufacturing labour force, as well as future requirements, is key to developing an evidence-based skills plan. Examples of knowledge gaps include:

- Which parts of manufacturing are making the shift to higher skills and which are not?
- Is there a mismatch between the supply and demand of labour skills in particular sub-industries? For example, companies have indicated a shortfall of knowledge in areas such as device physics and composites engineering.
- What specific qualifications are manufacturers demanding, and what common skills are manufacturers demanding across qualifications? What commercial skills would best complement the technical qualifications of graduates who are headed for the manufacturing industry?

103 US National Science Foundation (2002), 'Workshop on Nanomanufacturing and Processing: Summary Report', <https://www.nsf.gov/mps/dmr/nsfec_workshop_report.pdf>

104 CSIRO (draft: October 2016), 'Future of the Australian Advanced Manufacturing Industry – An Industry Roadmap'.

105 Proportion of survey respondents identifying each business improvement knowledge priority as having high impact or very high impact on their business: management (94%); workforce skills requirements (85%); international engagement (73%); industry 4.0 (63%); engaging in government procurement processes (52%).

106 Bloom, N. et al, (2007), 'Management Practice and Productivity: Why They Matter', *Management Matters*. Available at: www.growingjobs.org/downloads/management_practice.pdf. See also McKinsey & Company (2009), *Management Matters*.

- What skills are most likely to be demanded in the jobs of the future?
- How can we match, transfer and transform skills in declining manufacturing sub-industries with skills in growing manufacturing sub-industries?
- How can education service providers be more responsive to future economic needs?

International linkages

As outlined in Section 2, some manufacturing sub-industries currently under-serve key export markets, including for both intermediate and finished goods. Australia also has among the weakest backward linkages[107] of any major economy. Examples of knowledge gaps include:

- Which export markets are most under-served by each of the manufacturing sub-industries?
- What strategies should Australian manufacturing firms follow to identify and access international opportunities in these under-served markets?
- How can Australia improve its backward linkages in different sub-industries? What markets are most reputable and accessible for sourcing foreign components by sub-industry?

Driving digitalisation

As traditional production methods and business models evolve in today's internet-driven world, Australia is locked in a global race with countries that understand the industry is permanently changing. Embracing digitalisation is becoming pivotal to a nation's competitive advantage. Nations that rest on their laurels risk squandering their market position, while those that successfully transition to the digital age will be the manufacturing powerhouses of the future. Examples of knowledge gaps include:

- What opportunities does digitalisation have to offer Australian manufacturers? How can current trends in digital technology be scaled, and made relevant and accessible to the operations of Australian manufacturers, especially SMEs?
- How can more manufacturers gain access to digitalisation collaboration hubs to receive expert guidance, and test products and solutions?
- How can relevant new government initiatives be tailored to drive adoption, such as simplified grant schemes and expanded access to low-interest government-backed loans?

Leveraging government procurement

Government procurement provides Australian manufacturers with a large market opportunity, especially in industries such as defence, as well as areas of infrastructure investment such as rail. Similarly, Australian governments have the opportunity to leverage their procurement to drive innovation and collaboration between firms, and to create opportunities for Australian firms in global supply chains. Examples of knowledge gaps include:

- How can manufacturers be better appraised of upcoming procurement opportunities?
- How can Australia ensure a strong industry policy role in the forthcoming defence capability acquisition?
- What are the best ways to create spillover benefits arising from government procurement processes in areas such as defence to other industries?
- How can value differentiation and integration into global supply chains be prioritised and incentivised through civil and defence procurement processes?

Australia has a real opportunity to advance its manufacturing industry. The analysis and actions contained in this Manufacturing Competitiveness Plan will help to take Australian manufacturing to another level. As AMGC has observed, some firms have already made the transition to differentiating their value proposition and shifting their focus to higher-value market segments. Determined actions by companies and governments, along with further investigation into key Knowledge Priorities, can help other companies to make this transition, and high-performing companies to further advance. AMGC will work with all stakeholders to implement this Plan and harness the full potential of Australian manufacturing.

107 Backward linkages refer to the use of foreign inputs to produce goods and services for export.

> Australian manufacturing can only advance if companies lead the transition by focusing on competing on value.

6 THE CHANGING ROLE OF AMGC AND NEXT STEPS

6 THE CHANGING ROLE OF AMGC AND NEXT STEPS

6.1 OVERVIEW

AMGC is committed to creating a globally competitive manufacturing industry in Australia. Its role is to harness its unique position as an industry-led but government-supported Growth Centre by using three levers: (see Exhibit 40):

- **DIRECTION** Set the direction to advance manufacturing in Australia.
- **DEMONSTRATION** Demonstrate ways to achieve this direction by co-investing Australian Government funding for projects that support productivity, competitiveness and innovation within the industry.
- **AWARENESS** Work with companies and supportive industry bodies to help improve awareness, perception, and encourage action regarding competitive and resilient principles; also advise the Australian Government on policy to strengthen manufacturing and enhance firms' ability to scale.
- **IMPACT** To pursue industry-wide impact, AMGC will seek to influence the strategies pursued by companies and governments. Companies require a comprehensive understanding of the capabilities and requirements to advance manufacturing capability.

To perform all four of these functions, AMGC maintains close engagement with manufacturing industry associations, firms, academic institutions, and governments and their agencies. Joining AMGC's networks offers entry into a vibrant ecosystem where members gain access to early research results, networking opportunities and an invitation to participate in manufacturing online-learning. SMEs have the opportunity to expand their reach, large firms can discover agile supply chain partners, and ideas and research can be commercialised.

For further detail on the background of the Growth Centres Initiative, please visit AMGC's website at www.amgc.org.au.

> AMGC will advance manufacturing by setting direction, demonstrating the direction through projects and generate impact by influencing companies and government.

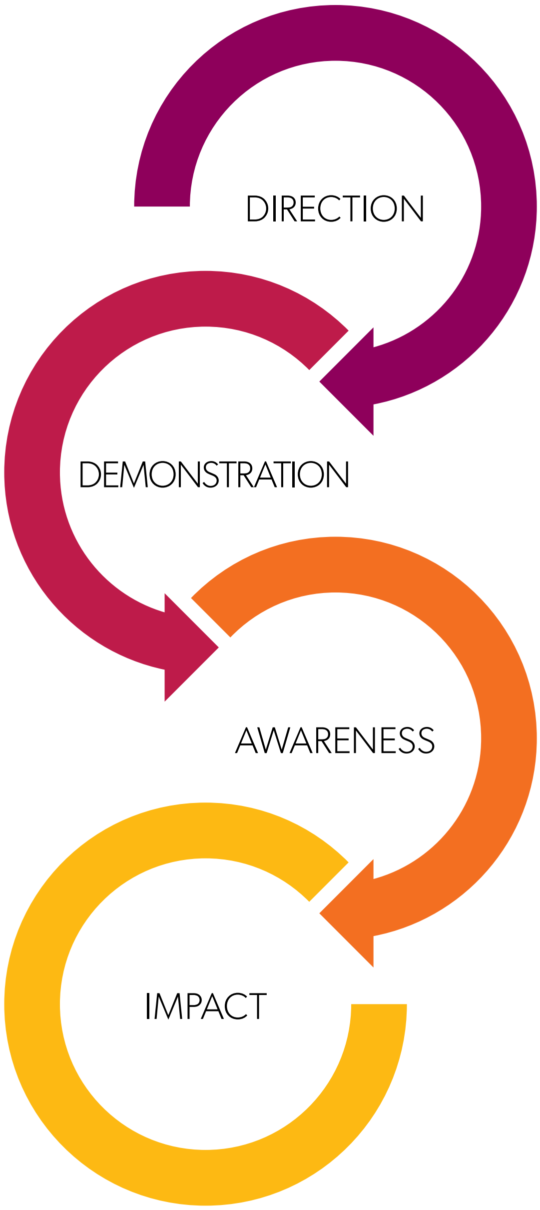
Exhibit 40

DIRECTION
AMGC will **set the direction** for how to advance Australian manufacturing through research analysis.

DEMONSTRATION
AMGC will **demonstrate how to pursue its direction** by co-investing in projects, and highlighting members that apply the identified strategic priorities.

AWARENESS
Work with manufacturers and industry bodies to improving awareness, perception, and encouraging action regarding competitive and resilient principles; advising the Australian Government on policy to strengthen manufacturing practices and enhancing firms' ability to scale.

IMPACT
AMGC will **generate awareness on direction best practices** throughout the manufacturing ecosystem through communication methods, events, and the Manufacturing Academy.



6 THE CHANGING ROLE OF AMGC AND NEXT STEPS

6.2 DIRECTION

AMGC conducted a thorough analysis on opportunities for the manufacturing industry that will drive growth.[108] This step is referred to as 'direction setting' within the *AMGC Manufacturing Competitiveness Plan*. From the analysis conducted in the *Manufacturing Competitiveness Plan*, AMGC identified that companies need to 'compete on value not on cost.' This encouraged other complementary analytical investigations to ensure a thorough needs assessment.

- *Manufacturing Competitiveness Plans*
- *Advanced Manufacturing: A New Definition for a New Era*
- *Advanced Manufacturing: Building Resilience in Australian Manufacturing*
- *10 Ways to Succeed in Australian Manufacturing*
- *Public Perceptions Report*

Industry's leadership in the transition to advanced manufacturing can be further guided and informed by investigating key Knowledge Priorities. Developing and disseminating knowledge is key to helping Australian manufacturing become more globally competitive.

Actions:

Over the next 12 months, AMGC will continue to submit industry reports, white papers and policy submissions informed by our research to identify regulatory issues and improve government's understanding of industry needs. AMGC anticipates the release of its research into Manufacturing Workforce Skills shortly.

6.3 DEMONSTRATION

AMGC will demonstrate how to pursue its direction highlighting members that apply the identified strategic priorities and by co-financing projects. First, AMGC will provide co-financing and management resources to support projects that apply the identified strategic priorities for the industry. The criteria for funding these projects will be based on the success factors for competitiveness outlined in our direction setting research. Successful projects that demonstrate the direction will be widely advertised. These demonstrations will provide tangible examples of how to apply best practice strategies, helping other companies identify their achievability and thereby improving their perception of the behaviour.

AMGC membership is a built ecosystem of like-minded constituents within the manufacturing industry that are committed to developing a more innovative, globally competitive manufacturing industry. Peer-to-peer communication have a strong link to changing perceptions and awareness. Through membership events and membership highlight opportunities, AMGC's members advocate to other manufacturing companies the identified best practices through interactions and demonstrations it can help other companies increase awareness and perceptions. The more manufacturing firms that can be a champion for the direction the higher the exposure of the message.

In addition to its current initiatives, AMGC continues to work on existing projects over the next 12 months.

Actions:

- AMGC will keep an open dialogue with manufacturers, research institutions and industry associations.
- AMGC will work with leading research institutions and groups of companies to deepen Australia's existing areas of comparative advantage, help fulfil the industry's unmet technology needs and link companies that would like to collaborate further.

108 Full reports can be viewed on the AMGC website.

6.4 AWARENESS

AMGC has been communicating its research findings since its establishment. Communication is fundamental to effectively promote messages that shift perceptions on manufacturing's future success. These messages address a wide audience and are evidenced by the theme of competing on value through developing value-driven products with the best people for the global market.

6.4.1 Manufacturing Academy

To further enable in-depth awareness and education on our direction setting at scale, AMGC uses an online learning platform to create a customised awareness and education solution with the capacity to evolve and develop over time. The Manufacturing Academy is a long-term engagement platform with online modules. Its primary goal is to leverage AMGC direction research and insights to educate and inspire Australian manufacturers to transform.

The Manufacturing Academy was expanded in 2021 with the launch of a new learning module titled 'Manufacturing with Rosie'. This seven-part module provides an overview of manufacturing opportunities in Australia and details the six National Manufacturing Priorities.

Actions:

Over the next 12 months, AMGC will continue to develop the Manufacturing Academy with new modules and further promotion to increase platform engagement and reach.

6.4.2 Events

AMGC will also communicate the key findings from AMGC research and the action areas that companies should pursue, via a series of roadshows and events. Events involve dissemination of AMGC direction setting research, manufacturing company and case study examples, and site visits.

Actions:

Over the next 12 months, AMGC will continue to host and participate in events across Australia.

6.4.3 COVID-19 Manufacturer Response Register

Launched in March 2020, the AMGC COVID-19 Manufacturer Response Register is an online platform that enables Australian manufacturers and individuals to register their interest and core competencies in support of the national response to COVID-19.

The Register is open to manufacturers, material and component suppliers, and individuals with expertise in design, engineering, manufacturing, or material production.

It enables registered used to identify collaboration and market opportunities in order to supply protective, medical or critical care equipment in response to the COVID-19 crisis. By collecting and collating data around the skills and capabilities of Australian manufacturers, AMGC is now able to match the overwhelming supply of help, with critical demand.

A key development this financial year was opening up the COVID-19 Manufacturer Response Register to international buyers in December 2020. Through the Register, international buyers gained access to critical care, medical and personal protective equipment (PPE) from Australian manufacturers and suppliers.

Actions:

In 2021–2022, AMGC envisions that it will transition the COVID-19 Manufacturer Response Register to an industry capability networking platform, allowing manufacturers to be connected – independent of COVID-19 – to share resources, fill gaps in their supply chains, source skilled labour and more.

6.4.4 Communication Methods

Evidence-based messages through different communication channels (presentations, industry events, Industry Edge newsletter, broadcast, print, online, videos, etc.) increase the manufacturing company's awareness surrounding value- driven best practices. Further communication methods that focus on inspiring or informing manufacturing companies about the benefits of competing on value through the identified best practices can reinforce a company's perception surrounding the transformation encouraging the companies to take steps for more information. Communication methods will be offered and shared with AMGC Members.

Actions:

Over the next 12 months, AMGC will continue to communicate the direction setting best practices associated with manufacturing advancement to Australian manufacturing firms. This will be achieved through media outreach.

> Through carefully selected projects with manufacturers, AMGC continued to build exposure and attention to the manufacturing industry leading to the growth of its membership initiative.

6.5 IMPACT

To collectively influence the entire manufacturing industry to transform, a comprehensive approach is needed to be employed thoughtfully over a long period of time to build momentum, support and widespread adoption. AMGC's approach to industry-wide impact aims to address the manufacturing ecosystem, with strong emphasis on awareness levels, belief systems, knowledge gaps and action reinforcement on the identified best practices described throughout the *Manufacturing Competitiveness Plan*. Impact will be generated by leveraging direction, demonstration and awareness strategies.

6.5.1 AMGC's maturation 'spill over' effect

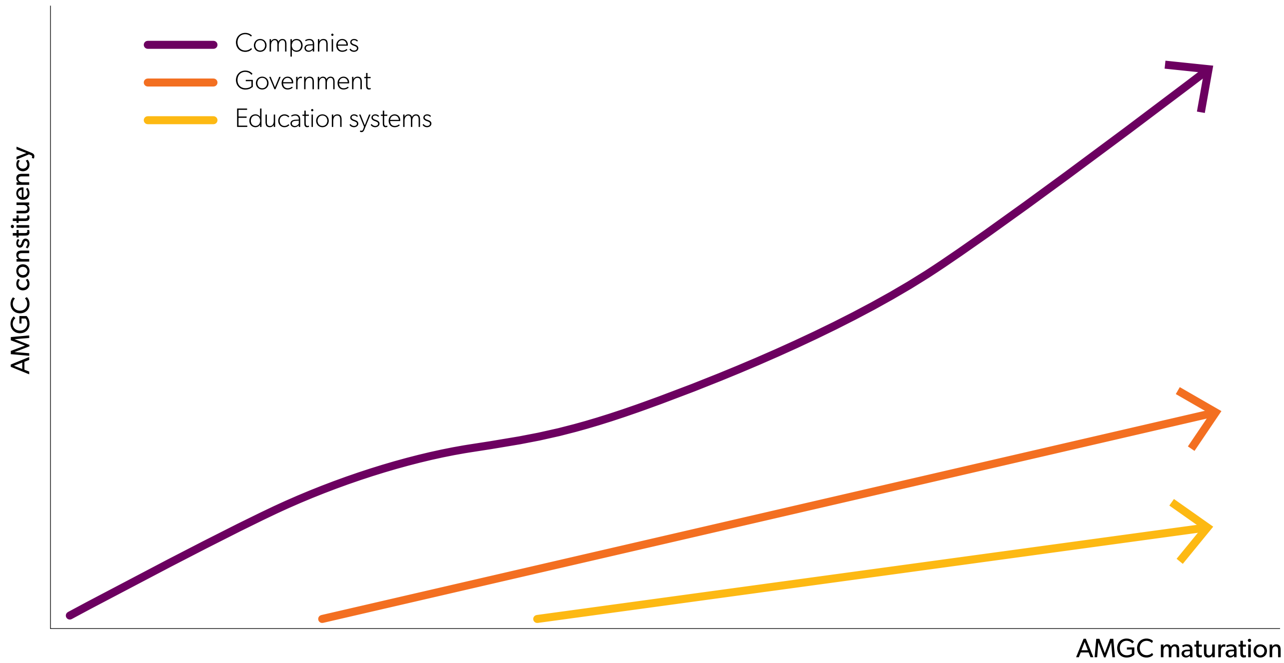
The Growth Centre Initiative created the six growth centres to build capability and stronger industry systems through a collaborative, industry-led process – to grow excellence and create an economy that ensures Australia's ongoing prosperity. When AMGC was established, the Growth Centre had to identify the best practices and opportunities that would give the industry clear direction and goals to achieve advancement. Succinctly, AMGC needed to start building a collaborative constituency to empower a collective force to share and drive transformation.

While discovering manufacturing industry best practices through our research, AMGC began to identify manufacturers that were already competing successfully on the global market. By acquiring these selected large ('Tier 1') and SME ('Tier 3') companies who were already achieving what was set out to do, provided increased exposure for AMGC and a 'foot in the door' within the manufacturing industry.

AMGC's globally competitive manufacturing member companies were ideal candidates for case study demonstrations of advanced characteristics through AMGC projects. Through carefully selected targets projects with manufacturers, AMGC continued to build exposure and attention to the manufacturing industry leading to the growth of its membership initiative. Members could now include not only manufacturing entities that already displayed advanced characteristics, but a broader membership base of those who are not as advanced yet.

Exhibit 41 – AMGC's spill over effect

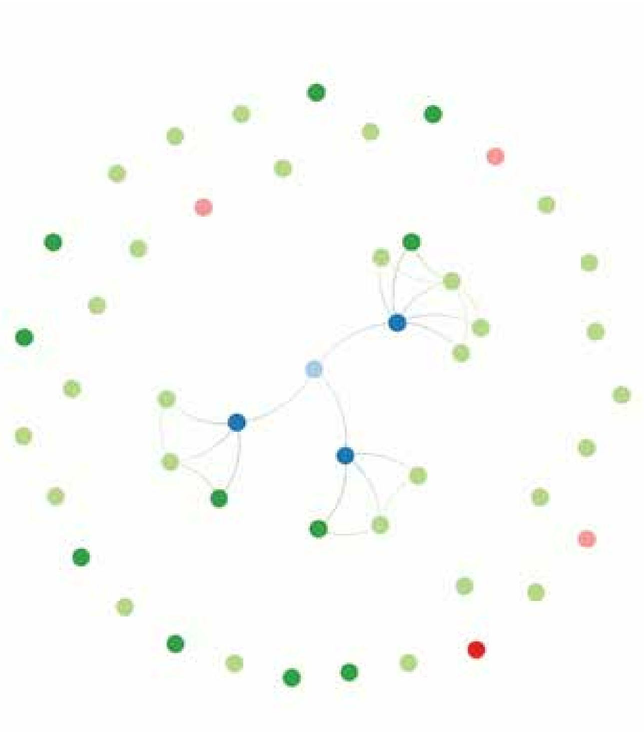
Sequence and impact of AMGC's initiatives and influence on the manufacturing industry over time



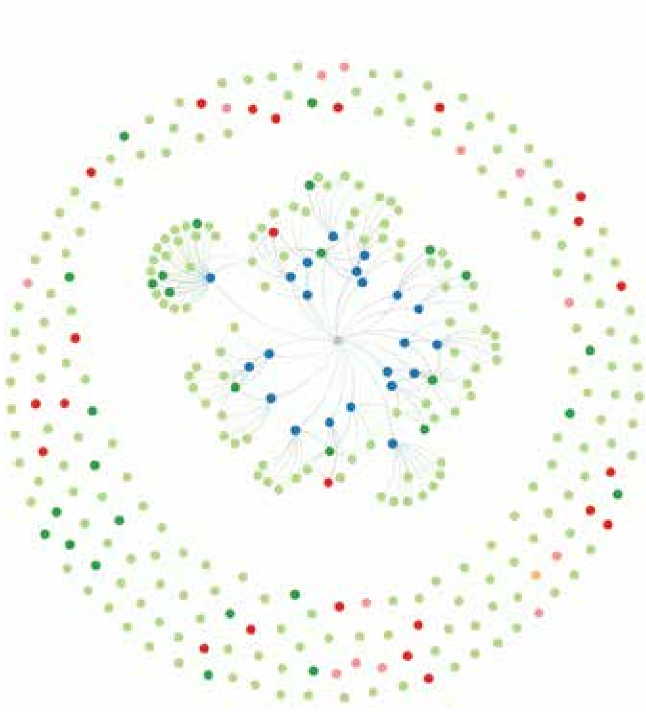
As AMGC initiatives and collaborations continue to mature, industry reach and support will grow, thus demonstrating an industry-wide 'spill over effect'. As AMGC gains more members, the reach and ability to advocate the discovered and evidenced competitive best practices to the wider industry will increase. As project case studies are demonstrating the practices in action, additional member interest and engagement will occur.

AMGC will continue growing its reach through the established initiatives. Throughout AMGC's existence, communication methods regarding the existence, activities, and gained collaborations have been and continue to be crucial to gain attention and support of the broader constituents. AMGC initiatives and ongoing advocacy with all stakeholders such as industry organisations, government and the education systems will further expand AMGC's reach and impact (Exhibit 42).

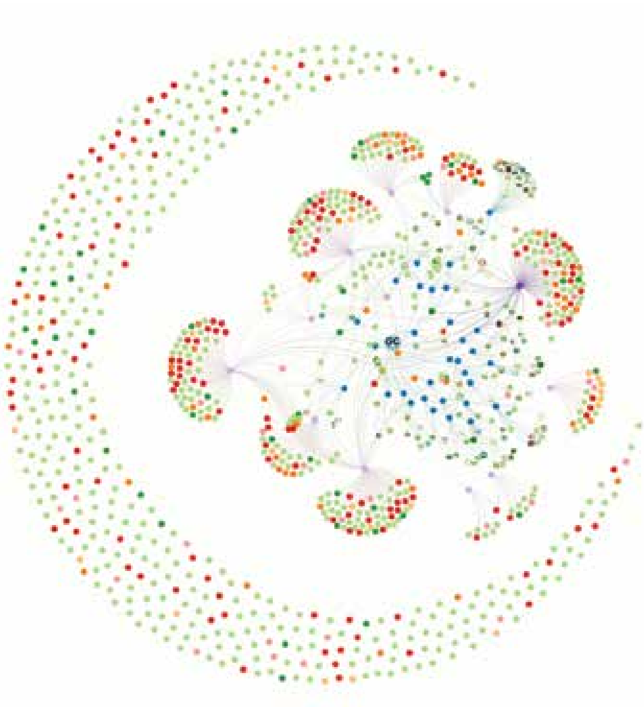
Exhibit 42



Legend
- AMGC
- AMGC Project
- Manufacturing Company
- Education/Research
- Industry Body/Network
- Professional Services

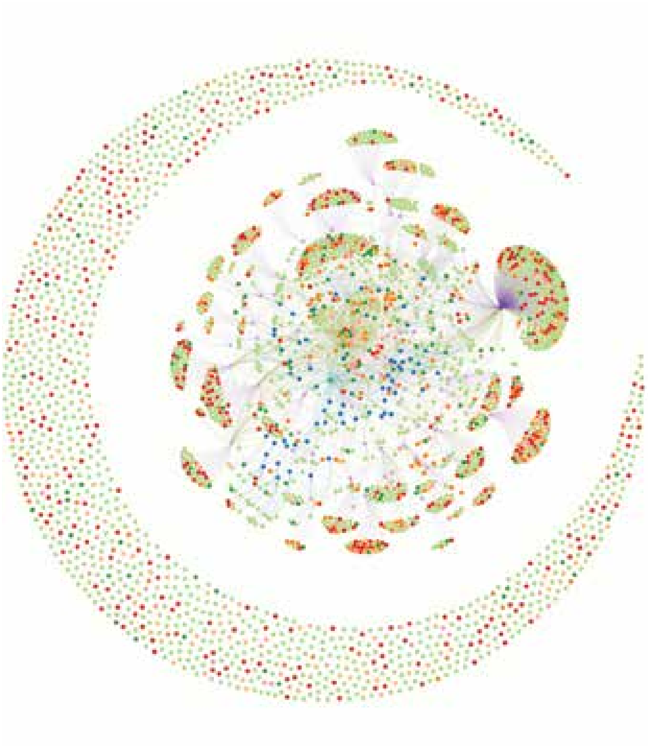


Legend
- AMGC
- AMGC Project
- Manufacturing Company
- Education/Research
- Industry Body/Network
- Professional Services
- Other



Legend

- AMGC
- AMGC Project
- Manufacturing Company
- Education/Research
- Industry Body/Network
- Professional Services
- Other
- Government
- AMGC Event
- Manufacturing Academy



Legend

- AMGC
- AMGC Project
- Manufacturing Company
- Education/Research
- Industry Body/Network
- Professional Services
- Other
- Government
- AMGC Event
- Manufacturing Academy

6.5.2 Impact on industry

Australian manufacturing can only advance if companies lead the transition by competing on value. A comprehensive understanding of the requirements to advance manufacturing is an essential enabler for progress.

AMGC will further reinforce direction setting priorities to create impact through connection building, co-financing projects, supporting applications exhibiting priorities (CRC-Ps, etc.), and aligning with government. As a result of co-financing projects, involved companies will begin to learn and adopt or maintain best practice strategies based on AMGC direction into their business models and practice directly.

Actions:

Over the next 12 months, AMGC will seek to influence companies by:

- **Prefabrication Innovation Hub:** AMGC was charged with the responsibility of conducting a feasibility study of establishing a Prefab Innovation Hub. The Steering Committee concluded that the Prefab Innovation Hub is feasible, and strongly recommends its establishment. If established, it will deliver the following outcomes:
  - support links between the construction and manufacturing industries to enable businesses to benefit from advanced manufacturing processes
  - support new technologies and innovations enabling the transformation of the industry to provide smarter, more affordable and more sustainable construction solutions for Australians
  - grow the manufactured buildings eco-system to improve business capability to incorporate advanced technologies and processes within industry

  In 2021–2022, AMGC will continue to manage the Hub program, which has seven key drivers:

  1. Smart Prefab and Digitalisation
  2. Design for Manufacture and Assembly (DfMA)
  3. Better Buildings and Bottom Lines
  4. Prefab Procurement Pathways
  5. Prefab Funding and Financing
  6. Navigating Regulations with Prefab
  7. Bushfires (and disaster recovery)

- **AMGC Meetings of Influence:** AMGC is consistently engaging with advanced manufacturers. Through this growing network they can connect manufacturers to companies and resources that engage in direction setting best practices.
- **Showcasing manufacturing success stories:** AMGC will publicise examples and case studies of firms that have successfully servitised their operations or otherwise transitioned to become more advanced manufacturers. This will be communicated via AMGC's website and mailing list, as well as through relevant industry associations.

Over the next 12 months, AMGC will evaluate direction, demonstration, and awareness levers for effectiveness on impacting company behaviour, and will update its strategy accordingly.

6.5.3 Impact on government

Governments can accelerate the transition of Australian firms to advance manufacturing. As an industry-led but government-supported body, AMGC is well positioned to ensure that government assistance is allocated impactfully. Drawing on analysis and learnings, AMGC will work with relevant government agencies to ensure that its policy, programs and regulations are aligned for impact.

This Manufacturing Competitiveness Plan identifies recommendations for government action in R&D, smarter procurement, smarter programs and changes in industry measurement.

- **Change the lens on manufacturing:** This will involve encouraging governments to reframe the image of manufacturing and help shift public perception towards a 'more advanced' and less production-centric industry.

- **Support business-led R&D:** AMGC will publicly support many of the recommendations outlined in the recent Review of the R&D Tax Incentive, including a shift in the mix of support for business-led R&D towards more direct instruments.
- **Encourage smarter civil procurement:** Working with the Department of Finance and procurement teams across government, AMGC will help to spread awareness of the key levers of manufacturing competitiveness. This is intended to shape how procurement opportunities can build the capability of firms in innovation, collaboration and links to global value chains.
- **Encourage smarter defence procurement:** The planned defence procurement program over the next decade is an historic opportunity for Australian manufacturing. It is essential that Australia leverages this opportunity to accelerate the industry's growth and transformation. AMGC will work with the Department of Defence to ensure strong industry policy objectives are achieved as part of upcoming strategic capability acquisitions and procurement. AMGC will support the Department of Defence by mapping capability among Australian manufacturers to support work in upcoming procurement activities. It is also important to understand best practice in designing defence procurement to maximise industry policy objectives such as building capability in sustainment, innovation, collaboration and export-readiness.
- **Identify under-served export markets:** AMGC will encourage Austrade to map under-served export markets for each manufacturing sub-industry, including for intermediate goods. *This Manufacturing Competitiveness Plan* uses the examples of medical technology and aerospace to show how a industry-wide analysis might look.
- **Optimise assistance:** In cooperation with the Department of Industry, Science, Energy and Resources, AMGC will advocate to align evaluation criteria for relevant funding and incentive programs with the characteristics associated with advanced manufacturing. AMGC is currently assisting the CRCs, CRC-Ps, ARC Industry Transformation Research Programme and R&D incentive programs.
- **Optimise capability-building:** In cooperation with The Department of Industry, Science, Energy and Resources and relevant state government departments, AMGC will advocate for programs that offer capability-building for SMEs and other manufacturing firms to encourage the development of characteristics associated with advanced manufacturing. For example, AMGC is currently working closely with the Entrepreneurs' Programme to inform leaders and business advisors about the ingredients required to understand manufacturing and to advance the industry.
- **Measure manufacturing:** More work will be done in collaboration with The Department of Industry, Science, Energy and Resources to change how manufacturing progress is measured. As outlined in Section 3, AMGC has been working to establish a new definition of 'manufacturing' that is not linked to a set of ANZSIC codes but relates more to a continuum of advancement reflecting the key characteristics of advanced knowledge, advanced processes and advanced business models.
  The department is currently working through the implications of this redefinition for measurement and evaluation purposes. AMGC will work further with the department to embed processes that track industry advances by prevalence of characteristics associated with being more advanced. As a first step, AMGC is currently working with the Department to test whether the characteristics associated with advancement among top-performing global manufacturing firms are present in successful Australian firms and how Australian firms currently perform against key 'advanced' characteristics.

> It is important to recognise that there is no single formula or 'one size fits all' approach to success.

7 APPENDIX

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7.1 MEASURING GLOBAL MANUFACTURING SUCCESS

Section 2 of this report summarised the method for measuring global manufacturing success and determining the characteristics associated with becoming more advanced. AMGC used Compustat – a global database containing firm-level indicators on 3,040 manufacturing companies – to identify the top-performing global companies for analysis.[110] The research team grouped together global manufacturing companies and other companies that invested in similar characteristics, from a list that included R&D intensity, capital efficiency, automation, services orientation and price density.[111] The researchers then removed missing values and outliers from the sample (see Exhibit A.1)[112], and found that top performers, by gross margin, earnings before interest and tax (EBIT), return on investment or labour productivity were also more likely to be top performers by total factor productivity. Based on this, total factor productivity[113] is the most realistic primary metric for success as it represents a key driver of competitiveness among Australian companies.

110 The analysis included all companies in the Compustat database that are primarily classified as manufacturers.

111 This hierarchical clustering was developed by constructing a dissimilarity matrix, which contains dissimilarity scores for any pair of firms. The dissimilarity scores are based on the distances among the set of variables (R&D intensity, value density, share of services, and automation and labour productivity). For any pair of firms, the further these metrics are from each other the more dissimilar each firm is. The researchers then created a tree diagram, where firms at the bottom are closer to each other (less dissimilar), and firms further up are further apart (more dissimilar). The different clusters were selected by cutting the tree diagram at specific points.

112 Outliers, based on the criteria of being 3.5 times the median absolute deviation away from the median, were selected and removed from the sample.

113 AMGC selected total factor productivity as the primary metric as it is more comprehensive than labour productivity (including capital productivity). Total factor productivity measures the joint productivity of capital and labour. It is not directly observable or measurable, so was derived by the residual of the regression of gross value added against capital and labour.

Exhibit A.1 – Success was defined by five metrics – total factor productivity, gross margin, ROI, EBIT and labour productivity

Total number of firms **3,040***	**Total factor productivity (TFP) metrics**	**Gross margin metrics**	**ROI metrics**	**EBIT% metrics**	**Labour productivity metrics**
Approach 1 Removing missing values	1,965	2,695	2,263	2,324	2,628
Approach 2 Removing outliers†	1,893	2,380	2,113	2,037	2,411
Approach 3 Identifying top quartile	**474** (A)	**595** (B)	**529**	**510**	**603**

(C): TFP, gross margin, ROI and EBIT% metrics

Three approaches as to how we determine successful firms

- **A** Assessing success as being in the top quartile for TFP produces **474** firms
- **B** Assessing success as being in the top quartile for gross margin produces **595** firms
- **C** Assessing success as being in the top quartile in at least two categories – TFP, GM, ROI or EBIT – produces **574** firms

* All firms in Compustat database primarily classified as manufacturers. Refer to appendix for details on calculation of success metrics.

† Outliers are selected and removed based on the criteria of being 3.5 times the absolute deviation from the median.

Source: Compustat, AlphaBeta/McKinsey analysis

Characteristics and success metrics in Compustat comprised a mix of directly observable and inferred fields. Exhibits A.2 and A.3 outline the calculation method used.

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Exhibit A.2 – Glossary of success metrics in Compustat data

Metric	Calculation method
Total factor productivity	Measures the joint productivity of capital and labour. It is not directly observable or measurable, and so was derived by the residual of the regression of gross value added against capital and labour.
Gross margin	(Sales – COGS)/sales
ROI	EBIT/average capital expenditure over 2013–2015
EBIT %	EBIT/sales
Labour productivity	Sales/employment

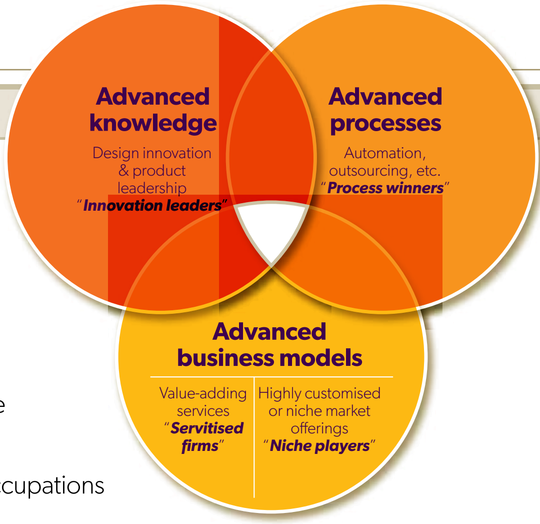
Source: Compustat. AlphaBeta/McKinsey analysis

Exhibit A.3 – Glossary of metrics used for each characteristic

	Characteristics
1 **Advanced knowledge**	R&D expenditure Patent portfolio Wage levels Qualifications of employees STEM skill intensity/ skill mix
2 **Advanced processes**	Capital efficiency Age of equipment Level of plant automation Energy efficiency Water efficiency
3 **Advanced business models**	Product value density Degree of backwards linkages Share of services

Source: Analysis conducted by Compustat, AlphaBeta/McKinsey analysis

Calculation method



- Ratio of R&D expenditure to total sales
- Number of patents by firms. Linked individual firms in Compustat to patents dataset
- Industry average wages weighted by the sales shares across industries by each firm
- Industry average of fraction of employees with bachelor or post-graduate degrees weighted by the sales shares across industries by each firm
- Using O*Net classification of STEM occupations, found share of these occupations in total employment for each industry,and weighted them by the sales shares across industries for each firm

- Ratio of total sales to plant, equipment and machinery
- Accumulated depreciation/depreciation
- Indicator = 1 if average growth in capital accumulation and labour productivity in the last three years is positive. Zero otherwise
- Used IO table to determine the value of energy in value of sales. Weighted the industries by the sale shares across industries by each firm
- Used IO table to determine the value of water in value of sales. Weighted the industries by the sale shares across industries by each firm

- Used four-digit industry level trade data, calculated value of shipment/weight. Weighted the value densities by the sales shares across industries by each firm
- Industry imports used to make industry exports. BEA IO tables. Weighted result by the sales shares across industries by each firm
- Sales of services/total sales by industry

7 APPENDIX

7.2 BACKGROUND ON BLADE

The research team used BLADE to understand the factors associated with success in Australian manufacturing, and the current picture of Australian manufacturing. Variables included in the analysis were primarily from three datasets within BLADE: the tax records of individual companies, the Business Characteristics Survey (BCS) and the Business Expenditure on R&D (BERD) survey.

Tax records data

After cleaning the data, there was tax record information for roughly 50,000 manufacturing companies. From this data the research team was able to distil measures of:

- labour productivity
- capital intensity – capital expenditure divided by total sales
- automation – whether the company experienced growth in real output, and its real investment
- trade intensity – total export of sales divided by the total value of sales
- whether the company exports – that is, total export sales are more than zero.

BCS data

About 3,000 companies had BCS information. The following variables were constructed from the data based to measure whether the company:

- uses patents to protect its intellectual property
- collaborates with any organisation for R&D
- collaborates for any purpose – this includes R&D, joint buying, joint production, joint marketing or distribution, or an integrated supply chain
- uses STEM skills in its core activities, noting that STEM includes Engineering, Science and Research, as well as IT professions, and IT technical support workers.
- increased its ICT expenditure
- introduced a new operational process
- introduced a new or significantly improved good or service
- uses product complexity as a way to protect its intellectual property
- introduced a new marketing method.

BERD data

The BERD data recorded 1,000 unique observations across three years. Based on this data, the researchers developed the following variable: R&D intensity minus R&D expenditure divided by total sales

Success metric

Because the researchers defined success as placing in the top quartile of labour productivity, it was important to make companies from different sectors comparable. It is possible for different industries to have different levels of labour productivity.

The research team standardised each industries labour productivity, which involved taking each company's labour productivity, subtracting the industry average and dividing the result by industry standard deviation. They then defined the industry at the level of the ANZSIC group. After constructing the standardised labour productivity measure across the manufacturing industry, companies were separated into quartiles.

Limitations

It was not possible to access the original raw data, so the research team used rules to remove extreme observations. Extreme observations were removed by winsorising the data, removing the top and bottom 5% of companies. This method appeared to remove implausible labour productivity values.

In addition, the researchers pooled BCS data from 2012–14 to ensure there were enough observations to compare the top and bottom quartiles in the manufacturing industry. For companies that had multiple observations, the researchers only retained the year that did not have missing values for all the BCS variables. For companies that had multiple observations with BCS answers, they kept the latest year. To ensure that the nominal variables such as labour productivity were comparable across the years, the researchers deflated each company's sales and value added using the ANZSIC Class Producer Price Index.

7.3 VOLATILITY ANALYSIS

Volatility was measured using regression analysis of industry value-added (IVA) contributions to gross domestic product (GDP) (see Exhibit A.4). To measure volatility, a line was fitted to account for trend changes in the size of the industry, such as inflation or structural economic changes. Each IVA series was de-trended by subtracting the pointwise estimate of the linear regression. The residuals were then treated as the 'cyclical component'. For each cyclical component, the standard deviation was calculated and divided by the mean size of the industry to arrive at a coefficient of variation; that is, the measure of volatility used in this study.

Volatility was measured across different countries, sectors and industries.

- Average volatility of international manufacturing industries was calculated over the period from 1996 to 2015. International comparisons used the OECD Structural Analysis (STAN) Database at the SITC Rev. 4 two-digit level. Australian comparison used the ABS IVA data at the two-digit level.
- Average volatility of Australian manufacturing industries was calculated over the period from 1987 to 2017. Manufacturing was measured at the two-digit level – except selected three- and four-digit industries – so that industries of similar sizes could be compared.

> Australia's manufacturing industry is volatile because the economy is relatively small, open and subject to significant swings.

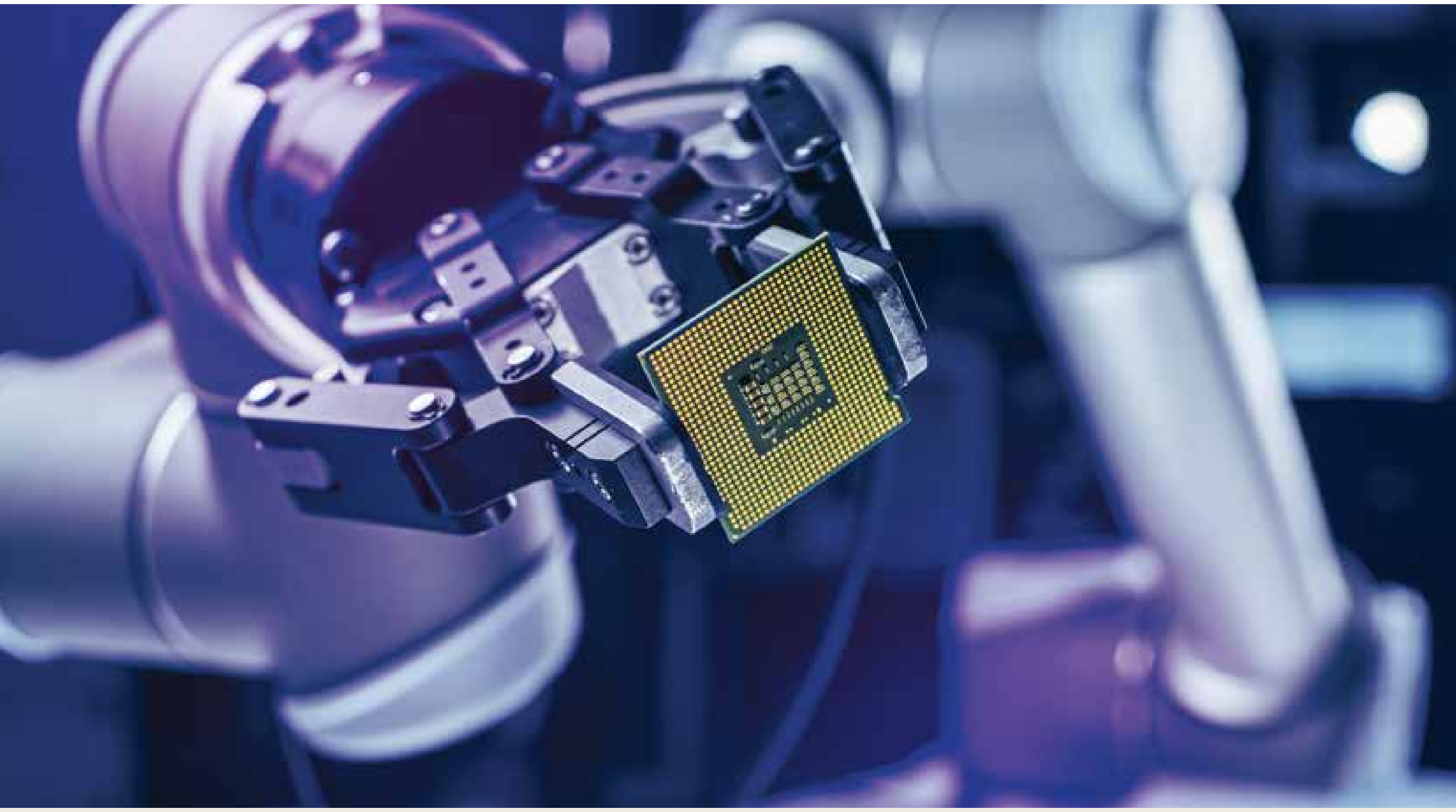


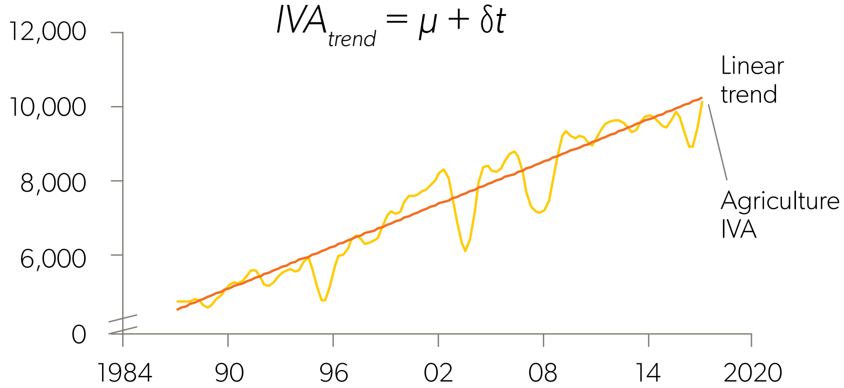
Exhibit A.4 – We used data on industry value added to develop a picture of volatility in industries

Step 1

Calculate linear trend in IVA to account for inflation effects and structural economic change.

Example calculation

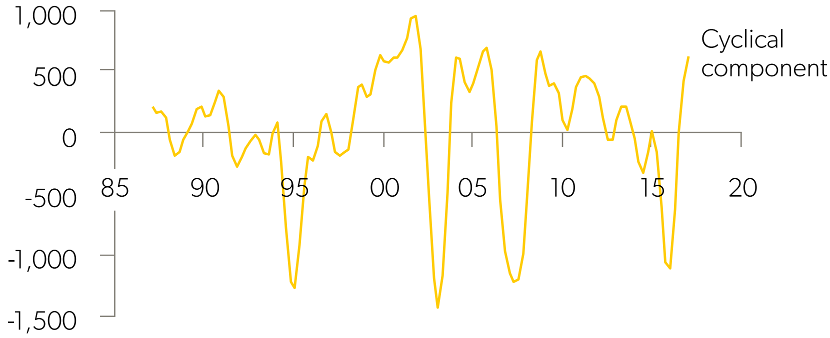
$$IVA_{trend} = \mu + \delta t$$



Step 2

Detrend IVA to leave cyclical component.

$$IVA_{industry} = IVA_{trend} + IVA_{cyclical}$$



Step 3

Measure volatility of cyclical component.

$$\text{Volatility} = \text{coefficient of variation} = \frac{sd(IVA_{cyclical})}{mean(IVA_{industry})}$$

1 Note: Method partly based on Cariolle, J. (2012). Measuring Macroeconomic Volatility. FERDI Working Paper No. 12.
Source: ABS, OECD StAN, AlphaBet/McKinsey analysis

Different calculations were used for other volatility calculations.

- The Sankey diagram measured the flow of Australian firms between performance quartiles in years before and during the GFC. Australian manufacturing firms with financial data available between 2003 and 2012 were selected from Compustat (N=301). The firms were divided into four quartiles of performance based on growth in EBIT in 2003–07 and then again in for 2008–12. The Sankey diagram maps the transition of firms between these quartiles before and after the GFC.
- The growth diagram measures changes in the size of Australian manufacturing industries. Change in IVA at the two-digit (and selected four-digit) level between 2012 and 2016 were graphed. For the two highlighted industries, financials for publicly listed firms and large private firms with available financial data were downloaded from the BvD Orbis database. The samples were restricted to those with at least three years of available financials between 2012 and 2016. Those with estimates calculated by BvD (rather than real data) were excluded. An average growth in revenue figure was calculated for the remaining firms (n=136 for mining and construction equipment manufacturing and n=59 for motor vehicle and parts manufacturing). Those with an average growth or more than zero were deemed to have grown between 2012 and 2016.

7.4 INTERNATIONAL FIRM ANALYSIS

The sample included 1,147 manufacturing firms through 40 downturn periods across manufacturing sub-industries in seven countries – the US, Canada, the UK, France, Germany, Italy and Sweden – between 1985 and 2016.

To identify downturns, AGMC used data from the OECD STAN Database on downturn periods in (two-digit) manufacturing industries at the country level. A downturn was defined to be three consecutive years of contraction at the industry level.

Financial data from 1985 to 2016 regarding manufacturing firms from a number of countries was downloaded from Compustat. Firms in the Compustat dataset that existed at the beginning of these downturns were identified. Analysis was restricted to downturns where at least 10 firms were involved at the start. This resulted in a sample size of 1,147 manufacturing firms through 40 downturn periods in seven countries.

Quartile regression was conducted to measure EBIT outperformance of the industry average throughout the length of a downturn. The independent variables were quartile performance in the five years leading up to a downturn in cost flexibility, R&D investment, workforce productivity and balance sheet (see Exhibit A.5).

Exhibit A.5 – Glossary of success metrics in Compustat data

Metric	Calculation method
Cost flexibility	Mean [change in sales/change in cost of goods sold] (when change in cost of goods sold >0) in years before downturn
R&D Investment	Mean R&D spend/sales over five years before downturn
Workforce productivity	Mean EBITDA/employment over five years before downturn
Strong balance sheet	Mean cash holdings/EBITDA in five years before downturn

Source: Compustat, AlphaBeta/McKinsey analysis

7.5 AUSTRALIAN FIRM ANALYSIS

Fifty resilient Australian manufacturers were analysed to determine the qualitative factors promoting business outperformance during recent periods of industry volatility. The sample comprised 13 in motor vehicle and parts manufacturing firms; 14 in construction and mining equipment manufacturing; nine in dairy product manufacturing; two in shipbuilding; and 12 in other manufacturing industries.

Interviews with company representatives or industry experts familiar with selected companies underpinned the quantitative analysis (see Exhibit A.6 for questions). Interview partners were asked to answer a key question: What factors enabled a firm to survive a recent industry downturn? These were grouped into several categories for the purpose of the study, covering each firm's business strategy, product offering, global trade links, innovation activities and workforce composition.

Exhibit A.6 – To investigate what drives resilience during volatility in Australia, we conducted a qualitative analysis of 50 firms that survived downturns

Question: What factors enabled the firm to survive through a downturn in the industry?

Product offering	**Technical leadership**	Did the firm have a technological or product advantage that customers value?
	Servitisation	Did the firm shift business towards services associated with product?
	Niche	Was the product highly specialised and niche?
	Product diversity	Did the firm spread risk across multiple product offerings?
	Intermediate goods	Did the firm produce intermediate goods?
Business strategy	**Agility**	Was the firm able to shift between different industries/products?
	Customer Diversity	Did the firm have a diverse, balanced customer base?
	Supplier Dependence	Was the firm dependent on a single or small number of suppliers?
	Government Grants	Did the firm receive government assistance during a downturn?
	Countercyclical strategy	Was the firm planning for downcycles through booms?
	Collaboration	Did the firm collaborate with other firms or institutions (e.g. joint buying, joint R&D)?
International linkages	**Export intensity**	Was the firm focused towards export markets?
	Geographical diversity	Did the firm have geographically disperse export markets?
	GVC participation	Was the product part of a global value chain?
Innovation activities	**Research and development**	Was the firm investing in research and development prior to the downturn?
	IP Protection	Did the firm have patents or other protections for IP?
Work-force	**Cost Flexibility**	Did the firm have the ability to flex variable costs, including labour?
	Upskilling	Did the firm invest in skilling its employees (e.g. ongoing training)?
	Automation	Did the firm shift towards less labour-intensive production?

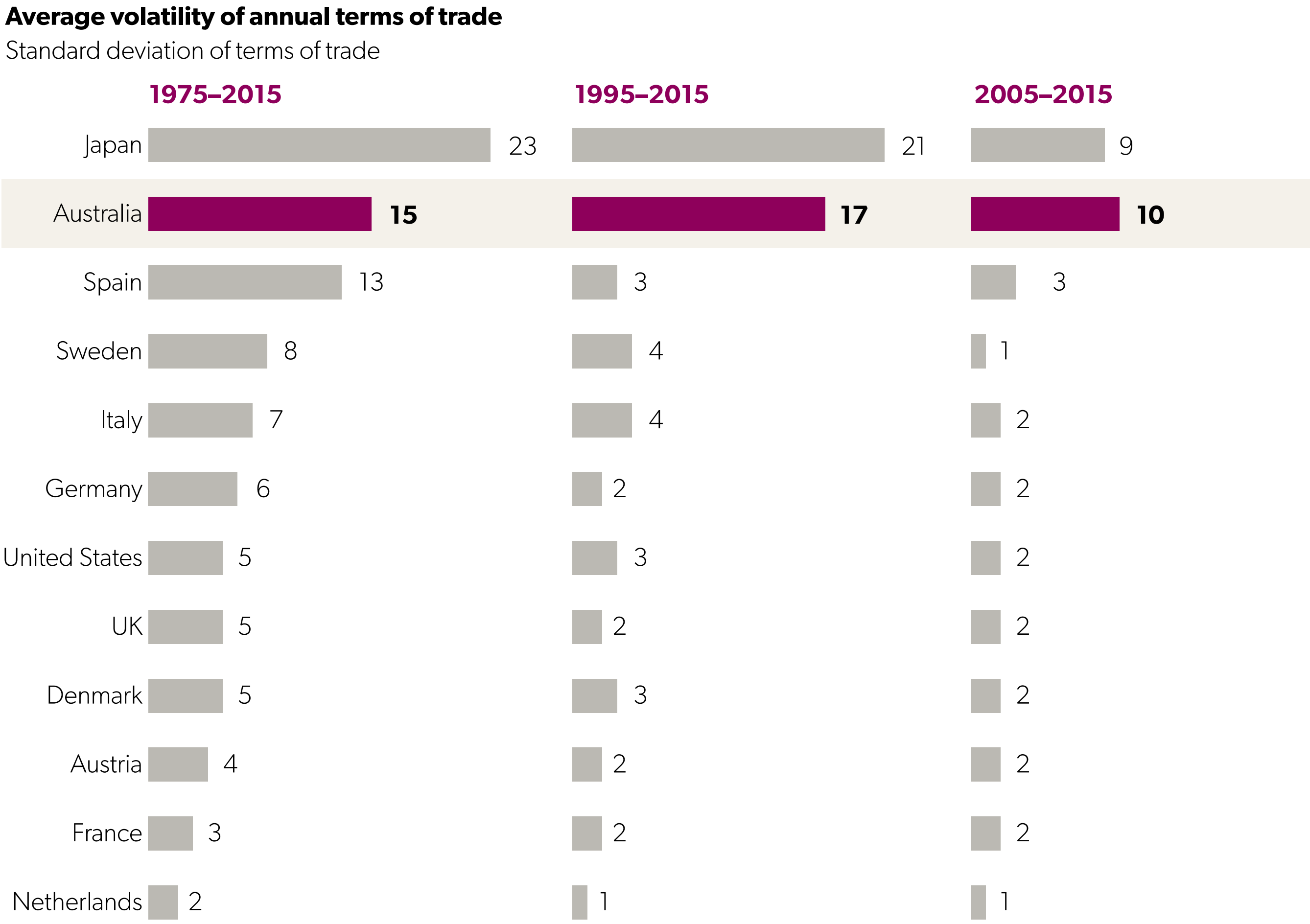
Source: AlphaBeta/McKinsey analysis

7.6 VOLATILITY IN AUSTRALIA

Australian manufacturing is unusually volatile. On average, Australian manufacturing sub-industries swell by 20% above their average size in upcycles and contract to 20% below their mean size in downturns – more so than in other countries. Australia's manufacturing industry is volatile because the economy is relatively small, open and subject to significant swings in its terms of trade, and geographic isolation magnifies fluctuations in the cost of transport.

Australia's terms of trade are among the most volatile in the world (see Exhibit A.8). From 2005 to 2015, they were more volatile than all major global economies.

Exhibit A.7 – Australia's terms of trade are among the most volatile in the world



Note: Volatility calculated by taking the standard deviation of annual terms of trade recordings.
Source: OECD

Australia's terms of trade are more volatile because the Australian dollar is more traded and more volatile than its peers. In 2016, the Australian dollar was the fifth most traded currency in the world despite Australia being the 22nd largest economy (see Exhibit A.9), making it much more volatile than other currencies (see Exhibit A.10).

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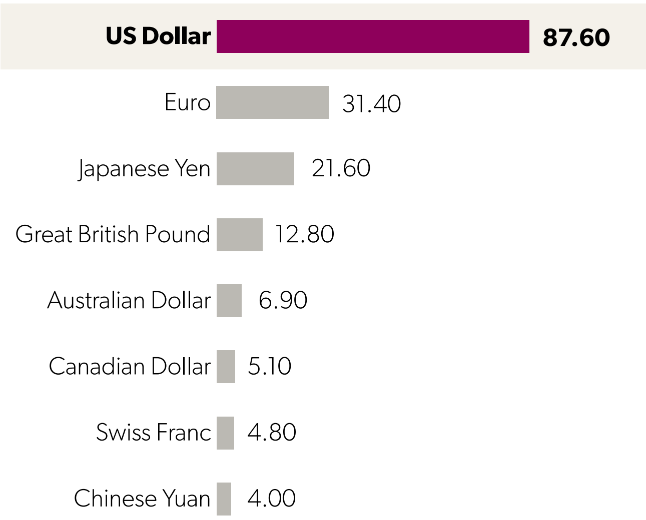
Exhibit A.8 – In 2016, Australia's currency was the fifth most traded in the world

Currency distribution of OTC foreign exchange turnover
Percentage share of average daily turnover in April 2016

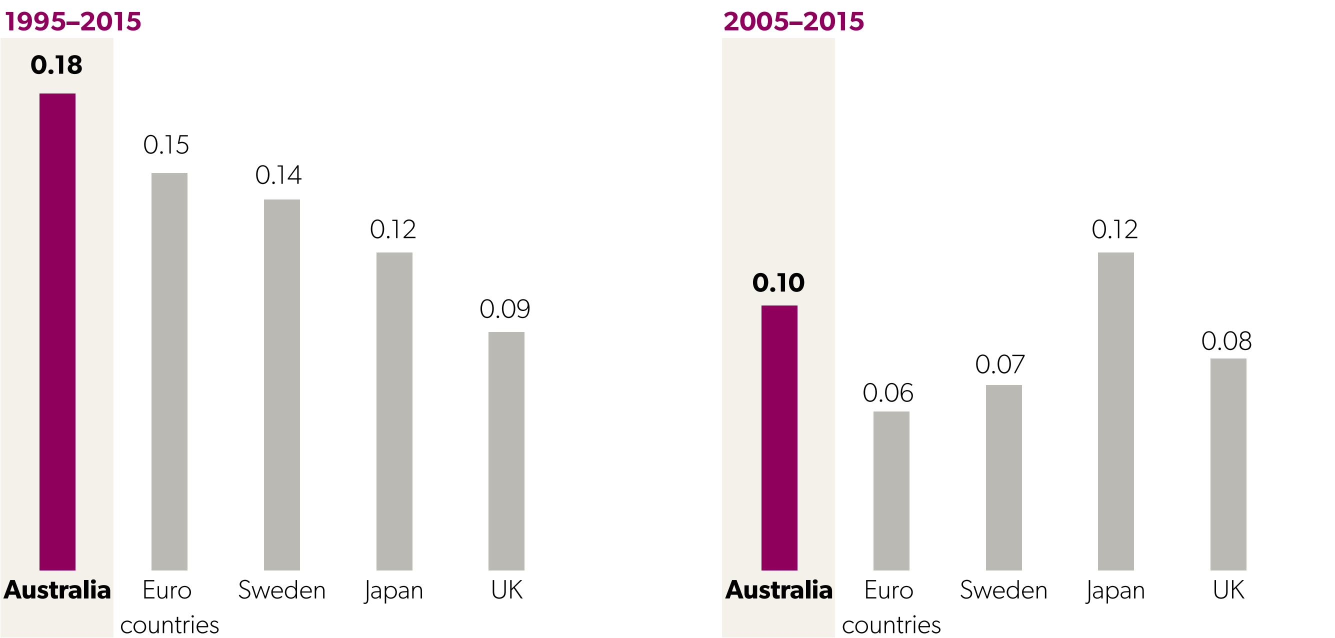


1 Adds to 200% because of two-way trade.
Source: Bank for International Settlements

Australia's terms of trade are also volatile because natural resources make up a large proportion of Australia's exports, and they are subject to significant commodity price fluctuations (see Exhibit A.10).

Exhibit A.9 – Australia's currency is also very volatile

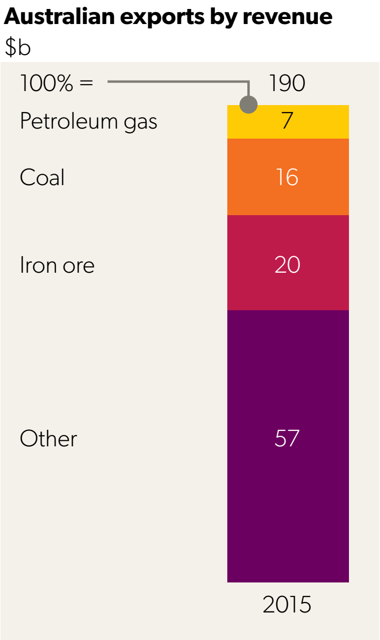
Average volatility of annual exchange rate
Standard deviation of monthly USD exchange rates



Note: Volatility calculated by taking the standard deviation of annual exchanges rate, with 2015 normalised to 1.
Source: OECD

Australia's terms of trade are also volatile because natural resources make up a large proportion of Australia's exports, and they are subject to significant commodity price fluctuations (see Exhibit A.10).

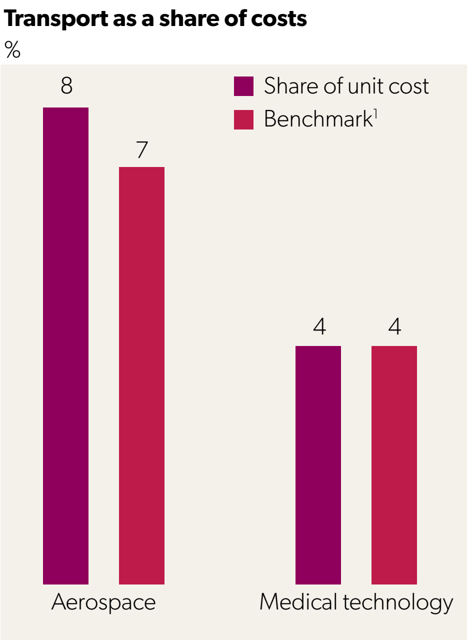
Exhibit A.10 – Australian exports are vulnerable to commodity price swings



Source: Observatory of Economic Complexity; IMF

Separately, Australia's geographic isolation magnifies volatility. Transport costs are higher for Australian manufacturers than for overseas manufacturers (see Exhibit A.8), so Australian firms are more exposed to rising transports costs – such as shipping costs.

Exhibit A.11 – Australia's transport costs are also subject to volatility



1 Benchmark compares Australian manufacturers shipping to Germany with US manufacturer shipping to Germany.
Source: SCP; Quandl

7.7 GLOSSARY

Term	Definition
Cost competitiveness	A competitive strategy that emphasises reductions in cost, so a firm can use lower prices to capture a larger market share, or boost profits at a given revenue point. AMGC emphasised this strategy in its *Manufacturing Competitiveness Plan 2017* as essential to building the competitiveness of Australian manufacturing firms.
Diversity	A competitive strategy of being present across multiple product segments, service offerings or geographic markets, to spread the risk of being affected by adverse conditions in any one segment or market. For example, a firm that caters to both local and international markets might be more able to withstand general economic downturns in the national economy. This also supports a firm's ability to be resilient.
Flexibility	A competitive strategy that strengthens the ability of a firm to change its products, services, processes or clients, supporting its ability to be resilient. In particular, flexibility refers to a firm's ability to adjust its costs (for example, by having variable contracts with suppliers) and change its business structure.
Market focus	A competitive strategy that seeks to strengthen a firm's performance by seeking out new geographic or product markets. AMGC emphasised this strategy in its *Manufacturing Competitiveness Plan 2017* as essential to building the competitiveness of Australian manufacturing firms.
MEST	Math, Engineering, Science and Technology. AMGC has chosen MEST over STEM to emphasise the preminent need of math skills for engineering, science and technology.
Resilience	The ability of firms to maintain stability despite external shocks. In this report, resilience refers specifically to firms' ability to maintain earnings growth that is above the industry average during periods of volatility.
Servitisation	A competitive strategy of offering services for sale attached to manufactured products. This includes selling workforce training and instruction sessions in conjunction with a new machine.
Superiority	The ability of a firm to compete against the market by offering a distinct product, service or way of operating that is difficult for other firms to emulate. For example, some firms may specialise in a niche product, cater to a tailored sub-industry of clients or offer a unique companion services, supporting the firm's ability to be resilient. This is distinguished from 'competitiveness' broadly, which refers to the ability of a firm to compete across any number of other strategies.
Technical leadership	A firm's ability to successfully offer products and services – or use production processes – that are more technically advanced than those of its competitors.
Value differentiation	A competitive strategy of providing distinct products or services so that the firm has fewer direct competitors in the market. AMGC emphasised this strategy in its *Manufacturing Competitiveness Plan 2017* as essential to building the competitiveness of Australian manufacturing firms.
Volatility	Variation in the output of an industry over a given period of time. This report measures volatility as the average ratio of the standard deviation of the fluctuation in an industry's output from a linear trend compared to the industry's size. See above for details on the volatility calculation methodology.

Learn more

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