

Advanced Manufacturing

A Roadmap for unlocking future growth
opportunities for Australia

EXECUTIVE SUMMARY

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CSIRO FUTURES

CSIRO Futures is the strategic advisory and foresight arm of Australia's national science agency.

Executive summary

Vision

Over the next 20 years, Australia’s manufacturing industry will transform into a highly integrated, collaborative and export-focused ecosystem that provides high-value customised solutions within global value chains.

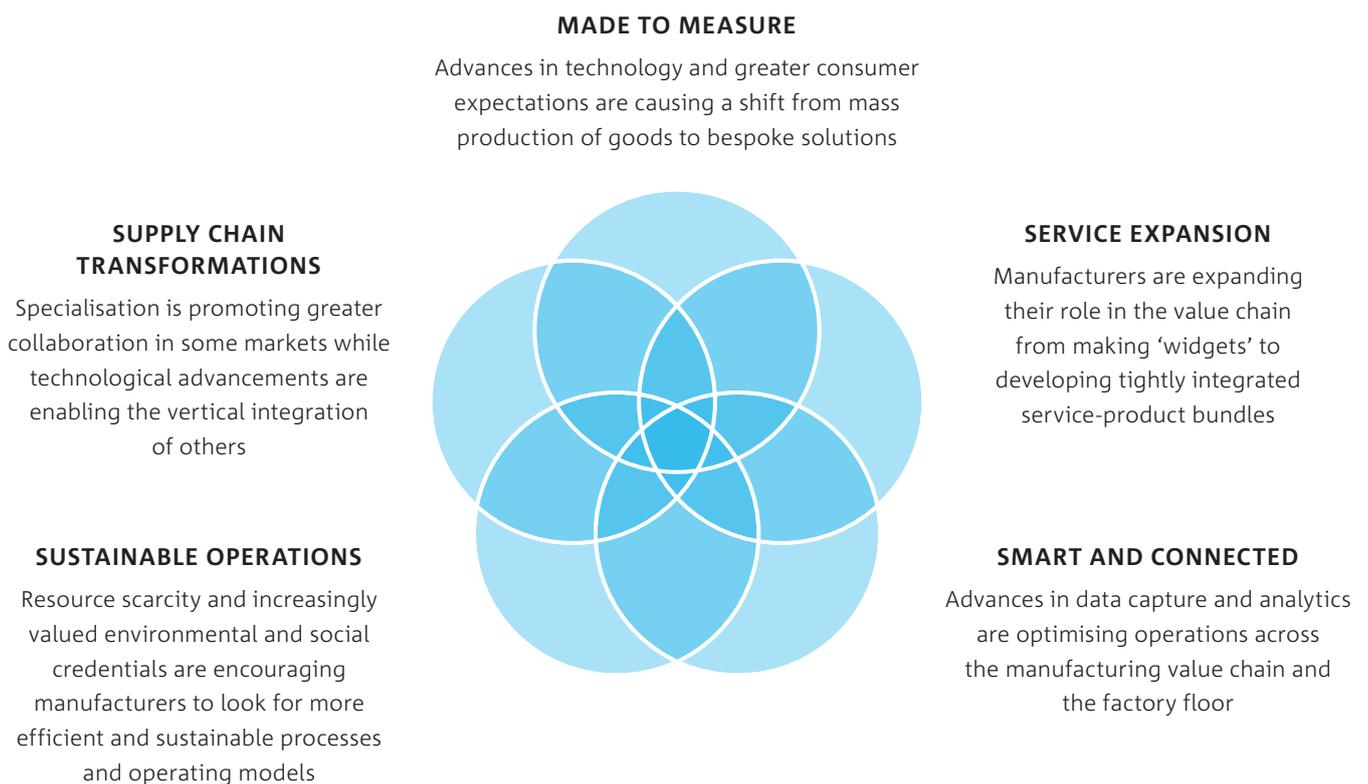
Australian manufacturing can and must be a thriving component of Australia’s economy through the application of advanced manufacturing technologies, systems and processes. The sector will focus on pre-production (design, R&D) and post-production (after-sales services) value-adding, sustainable manufacturing and low volume, high margin customised manufacturing.

The development and adoption of digitally connected technologies is important for all growth opportunities, as is the significant shift towards a more collaborative mentality. At the centre of this vision is an ecosystem where businesses, research, education and customers work together, embracing volatility and the opportunities that emerge from it.

A changing global landscape

Manufacturing markets across the world are being transformed by both demand and supply side drivers. The megatrends depicted in Figure 1 represent long term shifts in the sector that are creating new business models, social structures and cultural paradigms. To inform strategic decision making today, Australian manufacturers and their supporting ecosystem (industry bodies, suppliers, research, education, investors and governments) must consider what the global manufacturing landscape will look like over the coming decades.

FIGURE 1 – GLOBAL MANUFACTURING MEGATRENDS

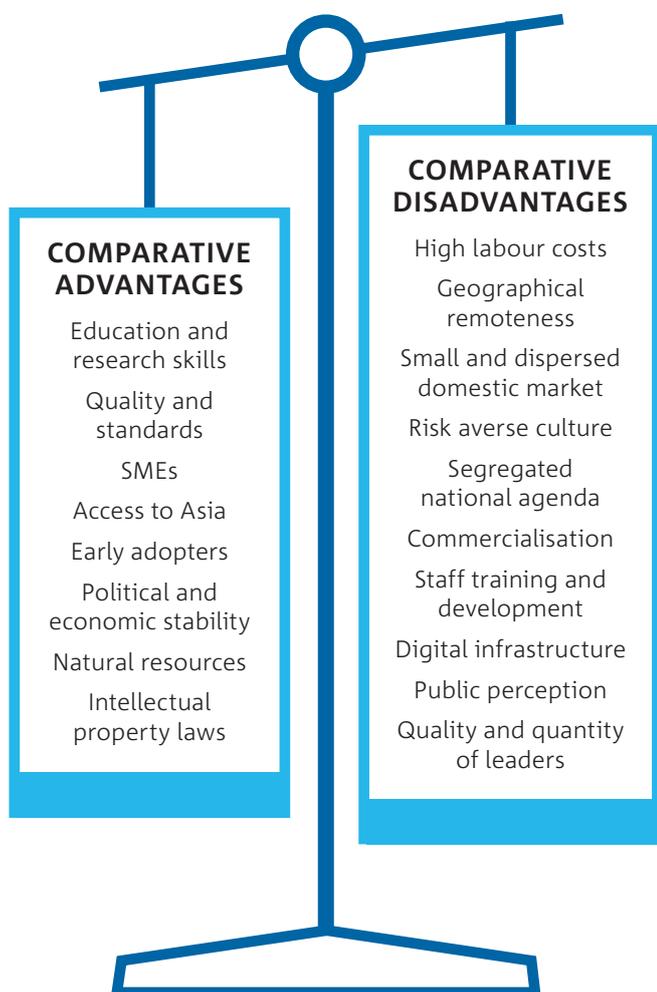




Australia's competitive landscape

Australia's role in this evolving global landscape will be dependent on the comparative advantages and disadvantages of manufacturers and their supportive ecosystem. Globalisation, digitalisation and the increased demand for more bespoke and complex solutions are causing Australia's long-standing disadvantages such as high labour costs, geographical remoteness and a small domestic market to be less important. However, manufacturers are also failing to capitalise on the full potential of Australia's advantages.

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Opportunities for growth

In considering Australia's competitive position in this rapidly changing global market, three broad opportunity themes have been identified. These themes are not mutually exclusive and strategic growth opportunities exist for manufacturers under each, with the largest falling across all three.



Customised high-margin solutions

- **DESIGN SERVICES:** From bespoke co-design with customers to manufacturer-less manufacturing
- **SUPERIOR COMPONENTRY:** From components with improved characteristics to components with completely new characteristics
- **NOVEL PRODUCTS:** From upgrades to existing products to complex and integrated novel solutions in health, defence and aerospace



Sustainable manufacturing

- **BUSINESS MODELS AND PROCESSES:** From reduced land use and wastage to closed-loop material use
- **PRODUCTS:** From energy efficient products to products designed with recycling, recovery and collaborative consumption in mind



Selling services

- **MAINTENANCE AND REPAIR SERVICES:** From static monitoring, diagnostics and predictive services to ingestible / embedded and intelligent sensors
- **WORKFLOW MANAGEMENT SERVICES:** From wearable tracking devices and bundling of add-on services to performance-based contracts and interactive platforms that allow informed decision making
- **HEALTH AND BIOSECURITY SERVICES:** From discrete monitoring functions to integrated and continual reporting for advanced warning

Enabling science and technology

Strategic growth opportunities for Australia’s manufacturing sector will be underpinned and supported by significant technological innovation from public and private research communities. In an increasingly competitive global landscape, continual improvement and investment in R&D is the only way to remain competitive. The following technologies support product differentiation through superior and customised attributes; efficiency improvements across production floors and value chains; and real-time monitoring for data driven decision making.

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TABLE 1 – ENABLING SCIENCE AND TECHNOLOGY SUMMARY

	NOW	IN THE FUTURE
Sensors and data analytics	Predominantly used during production (remote monitoring of single attributes such as temperature or flow rates).	Applied across the value chain, including predictive maintenance, logistical tracking for operational efficiencies, quality control and service offering (when integrated into end product).
Advanced materials	Reactive use to address specific product limitations e.g. enhanced durability, weight, look and feel.	Proactive integration at early design phase to offer multiple novel attributes e.g. biocompatibility, biodegradability, energy efficiency and self-repairing.
Smart robotics and automation	Replace workers for tasks that are complex, high precision, repetitive, dull or hazardous e.g. handling operations and robotic welding.	Assistive robots that work collaboratively with humans and each other, with improved sensing, awareness and decision-making capabilities that allow full autonomy and self-learning behaviour.
Additive manufacturing (3D printing)	Prototyping and one-off production runs of customised high-value complex metal componentry and low-value consumer products, with high capital costs stalling wider spread adoption.	Reduced capital costs will allow greater adoption of the technology for production of complete complex products and associated advanced business models such as customer-led design processes and just-in-time production.
Augmented and virtual reality	Predominantly restricted to gaming and consumer electronic markets, with limited use in the manufacturing sector.	Used to overlay product designs with end-use environments, optimise machine settings in the virtual world, facilitate remote collaboration and train or guide workers through complex/dangerous tasks.



Enabling actions

In order to pursue the strategic growth opportunities and realise the full potential of their enabling science and technology areas, Australian manufacturers must proactively transform the way they run their businesses, investing in new knowledge and practices. Positioning for sustainable growth will require business changes both internally (new skillsets, cultures and operating systems) and externally (participation in global value chains and collaboration models).

Improving Australia's place in the global manufacturing sector requires bold innovation leadership and investment now. If Australian businesses do not act today – both individually and collaboratively – they risk losing access to emerging markets and new sources of competitive

advantage to international competitors. Together, the Australian manufacturing ecosystem has the potential to unlock a new wave of growth; one that builds on Australia's high-value adding activities in R&D, design and after-sales services. Future success will be determined by the decisions made from here forward and the quality of the science, technology and business conversations that underpin them.

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TABLE 2 – ENABLING ACTIONS SUMMARY

Global value chains (GVCs)	Skills, training and the workforce	Collaboration and culture
BUSINESS ACTIONS		
<ul style="list-style-type: none"> • Promote capabilities internationally through increased licensing, novel sales approaches and targeting GVCs from product creation stage. • Align digital systems with world-leading best practice to improve interoperability with global partners. • Increase knowledge sharing with experienced Australian GVC operators. 	<ul style="list-style-type: none"> • Develop digital literacy, leadership and strategic management, customer interface and STEM skills. • Develop programs to improve skills recruitment and development e.g. graduate programs, structured training courses and site tours. • Increase diversity in the workplace – specifically a greater representation of young and female employees. 	<ul style="list-style-type: none"> • Increase use of joint-investment models e.g. pooling of SME funds and co-investment with research organisations. • Invest in cloud computing and collaborative software to allow greater value chain communication and rapid adaptation to changes in demand. • Develop business placement opportunities for researchers to enhance knowledge sharing.
ECOSYSTEM ACTIONS		
<ul style="list-style-type: none"> • Address interoperability barriers by implementing more appropriate and sophisticated industry data standards, in consultation with companies. • Identify and implement effective and streamlined standardised regulation and compliance protocols both within and between jurisdictions. • Conduct social research studies to better understand and address social licence to operate issues for the adoption of enabling technologies in different global markets. 	<ul style="list-style-type: none"> • More closely integrate theory and industry application in tertiary education courses, including developing additional industry placement opportunities for tertiary students. • Promote manufacturing as the destination for new creative, high-skilled and interdisciplinary jobs to address public perception issues and attract skilled labour. • Develop tailored training courses for the re-skilling of transitioning employees and for researchers to enhance pitching/presentation skills. 	<ul style="list-style-type: none"> • Improve business access to advanced manufacturing research facilities for education and early product development. • Encourage the development of consortia bidding through government procurement strategies. • Support planned co-locations of business, research and/or education.

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WE IMAGINE
WE COLLABORATE
WE INNOVATE

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