ADVANCED MANUFACTURING GROWTH CENTRE

INDUSTRY KNOWLEDGE PRIORITIES 2016

AMGC
ADVANCED MANUFACTURING GROWTH CENTRE LTD

ADVANCED MANUFACTURING INDUSTRY KNOWLEDGE PRIORITIES

Developing and disseminating knowledge is key to helping Australian manufacturing differentiate itself on value and drive technical leadership.

As part of its function as an Industry Growth Centre, the AMGC has identified both Research and Development and business improvement knowledge priorities, to help support research and analytical efforts for the sector.

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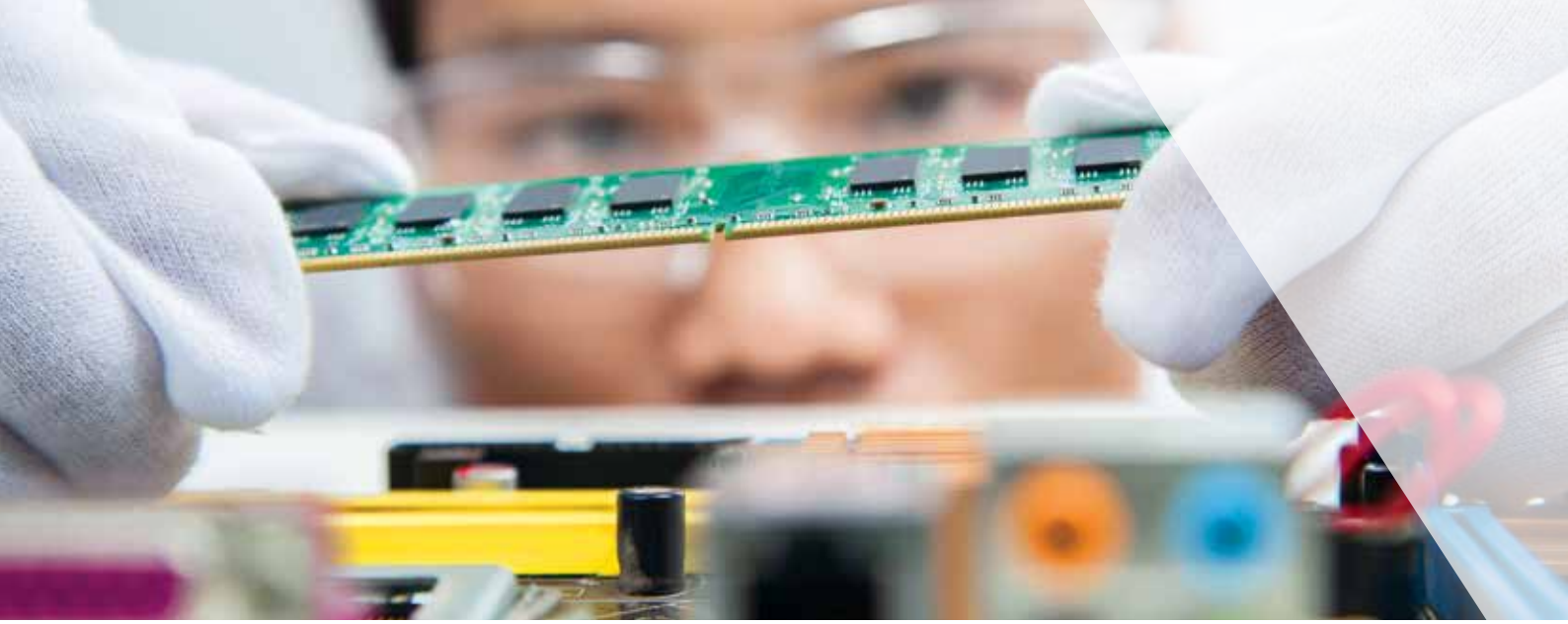

1 OBJECTIVES OF KNOWLEDGE PRIORITIES

The AMGC has identified two types of Knowledge Priorities which will need to be addressed in order to enhance the competitiveness of the Australian manufacturing sector:

1. Research and Development priorities – these are technological and scientific gaps that can help to improve manufacturing processes or drive product innovation
2. Business improvement priorities – these are analytical priorities aimed at better understanding business capability gaps and the best ways to overcome these gaps

These Knowledge Priorities will be used to:

- Inform the research community about the R&D priorities of industry
- Inform selection processes for government R&D assistance in manufacturing
- Direct the analytical and service delivery efforts of policy makers, industry associations, and business support services that target improved business capabilities in manufacturing
- Advise manufacturing firms seeking direction on how best to invest in building knowledge
- Inform the future work of the AMGC.

2 HOW WERE THESE KNOWLEDGE PRIORITIES **IDENTIFIED?**

The Knowledge Priorities outlined below are the result of our competitiveness analysis of the Australian manufacturing sector, a review of the existing literature, and industry engagement including consultations and a Knowledge Priorities survey with over 50 respondents from industry associations, companies, government agencies and research institutions.

The Priorities will be updated according to industry need. The AMGC will conduct ongoing literature reviews and survey to update the Priorities.

Analysis of manufacturing sector

The AMGC carried out competitiveness analysis of Australian manufacturing to help identify challenges and opportunities for the sector. The AMGC's Sector Competitiveness Plan identified the importance of firms increasing technical excellence in their products and expanding their value-adding services. The Knowledge Priorities for both R&D and business improvement are targeted towards helping firms compete on value.

Literature review

We added to our original analysis by consulting a wide variety of existing literature on the future of advanced manufacturing here and in international markets. Studies by CSIRO, industry associations, universities and private firms were all consulted.[1] We looked also to the National Science and Research Priorities and Practical Research Challenges endorsed by the Commonwealth Science Council. Key international sources, from foreign governments, industry associations and organisations such as the OECD supplemented the domestic analysis.

Industry engagement and survey

The AMGC has been engaged in regular industry consultation over the past year with industry associations, manufacturing firms, and government and research organisations.

We also carried out an industry survey across firms, industry associations, research institutions and government agencies which sought input on our proposed list of Knowledge Priorities. 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.

1 CSIRO (Draft: October 2016), "Future of the Australian Advanced Manufacturing Industry – An Industry Roadmap"; CEDA (April 2014), "Advanced Manufacturing: Beyond the Production Line"; White House (April 2016), "Advanced Manufacturing: A Snapshot of Priority Technology Areas Across the Federal Government"; US National Science Foundation (2002), "Workshop on Nanomanufacturing & Processing: Summary Report"; M. A. White (2011), "Physical Properties of Materials"; Princeton University Press, "The Properties of Materials"; Industry Canada (2006), "The Canadian Biopharmaceutical Industry Technology Roadmap"

3 WHAT ARE **AUSTRALIAN MANUFACTURING'S** RESEARCH AND DEVELOPMENT PRIORITIES?

Australian manufacturing businesses, industry associations and the research community have identified a number of Research and Development priorities to help Australian manufacturing become globally competitive by increasing the technical leadership in their products and expand their associated value-adding services. The following list is ranked in order of importance and impact as identified by the survey and sources listed in the previous section.[2] 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

Definition and application in manufacturing: Robotics and automated production processes refer to the design and operation of robots in manufacturing,[3] enabling greater productivity, lower costs, improved workplace safety and higher product quality.

Examples of knowledge gaps in Robotics and automated production processes 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'?[4]
- How can robots better develop situational awareness (vision and sensor developments) to interact with workers and customers and in controlled environments?
- How can software be improved to enable robots to communicate with one another and other manufacturing equipment/processes?

2 Proportion of survey respondents identifying each R&D knowledge priority as being Relevant or Very Relevant: Robotics and Automation (78%); Advanced materials and composites (76%); Digital Design and Prototyping (75%); Sustainable Manufacturing and Life Cycle engineering (82%); Additive manufacturing (78%); Sensors and data analysis (68%); Materials resilience and repair (65%); Bio-manufacturing (55%); Nano- Micro- and Precision manufacturing (55%); Augmented or Virtual Reality manufacturing (50%).

3 CSIRO (Draft: October 2016), "Future of the Australian Advanced Manufacturing Industry – An Industry Roadmap"

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

Advanced materials and composites

Definition and application in manufacturing: Advanced materials and composites refer to new materials developed to provide superior performance across a variety of dimensions (e.g. strength, weight or flexibility),[5] enabling greater product differentiation and customisation for manufacturers.

Examples of knowledge gaps in Advanced materials and composites include:

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

Digital design and rapid prototyping

Definition and application in manufacturing: Digital design and rapid prototyping refer to the product development cycles enabled by ICT visualisation and analytic tools,[6] providing lower product development costs and greater product customisation opportunities to manufacturers.

Examples of knowledge gaps in Digital design and rapid prototyping 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 as to enable manufacturers to create highly customised products?
- How can small scale production be made more cost-effective so that smaller Australian manufacturers can viably engage in design-led production?

Sustainable manufacturing and life cycle engineering

Definition and application in manufacturing: 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.[7] Sustainable manufacturing presents an opportunity for reduced costs and greater ability to meet eco-conscious market demand.

Examples of knowledge gaps in Sustainable Manufacturing and Life Cycle engineering include:

- How can waste capture opportunities in the production cycle be identified and taken advantage of?
- 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 into the future?

Additive manufacturing

Definition and application in manufacturing: Additive manufacturing (also known as 3D printing) 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 in Additive manufacturing include:

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

5 CSIRO (Draft: October 2016), "Future of the Australian Advanced Manufacturing Industry – An Industry Roadmap"

6 CEDA (April 2014), "Advanced Manufacturing: Beyond the Production Line", http://www.ceda.com.au/research-and-policy/research/2014/04/30/advancedmanufacturing; CSIRO (Draft: October 2016), "Future of the Australian Advanced Manufacturing Industry – An Industry Roadmap"

7 CSIRO (Draft: October 2016), "Future of the Australian Advanced Manufacturing Industry – An Industry Roadmap"

3 WHAT ARE **AUSTRALIAN MANUFACTURING'S** RESEARCH AND DEVELOPMENT PRIORITIES?

Sensors and data analysis

Definition and application in manufacturing: Sensors and data analysis refers to the use of devices to monitor, control and diagnose issues with production lines in real time, enabling increased production volumes and reduced downtime.[8]

Examples of knowledge gaps in Sensors and data analysis 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 have to be solved in order 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, bio-degradable, bio-compatible, and wirelessly connective?
- How can systems increase data storage and security to handle higher capture and security threats?

Materials resilience and repair

Definition and application in manufacturing: Materials resilience and repair refers to the ability of a material under stress to absorb energy and return to its original state,[9] enabling product performance characteristics including strength, flexibility and durability.

Examples of knowledge gaps in Materials resilience and repair include:

- How can material behaviour and complex processes such as flow chemistry be better modelled so as to increase material resilience?
- How can scanning or other methods be enhanced in order 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

Definition and application in manufacturing: Bio-manufacturing and biological integration refers to the use of biological systems to produce molecules that cannot be extracted or synthesised directly,[10] enabling the development of innovative products and materials.

Examples of knowledge gaps in Bio-manufacturing and biological integration include:

- Can more advanced forms of resilient bio-degradable packaging solutions be found?
- What high value compounds and new materials can be created utilising 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?

Nano, micro, and precision manufacturing

Definition and application in manufacturing: Nano-, micro- and precision manufacturing refers to production that uses very small-scale components and materials or applies high-precision tools[11] to improve product performance characteristics, enabling a high degree of product differentiation and customisation opportunity for manufacturers.

Examples of knowledge gaps in Nano, micro, and precision Manufacturing include:

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

8 CSIRO (Draft: October 2016), "Future of the Australian Advanced Manufacturing Industry – An Industry Roadmap"

9 M. A. White (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;

10 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

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

Augmented or virtual reality systems

Definition and application in manufacturing: Augmented or virtual reality systems refers to technology that engages workers with a computer-generated representation of the physical world, enabling remote control of machinery or guiding workers through operations on-site[12] and thereby ultimately improving cost and safety outcomes.

Examples of knowledge gaps in Augmented or virtual reality systems include:

- How can augmented reality be used to allow closer human-machine interaction in product design and manufacture including through 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 technology are best suited to manufacturers in different contexts: on the factory floor, exhibiting to a client, or testing product use?
- How can the computability of software platforms be enhanced?

12 CSIRO (Draft: October 2016), "Future of the Australian Advanced Manufacturing Industry – An Industry Roadmap"

4 WHAT ARE **AUSTRALIAN MANUFACTURING'S** BUSINESS IMPROVEMENT KNOWLEDGE PRIORITIES?

The following Knowledge Priorities for business improvement are ranked in order of impact as identified by survey of over 50 industry representatives, from manufacturing firms, industry associations, government and research organisations.[13]

Drivers of the management capability gap

Recent studies have demonstrated that Australia has a longer tail of manufacturing companies that perform poorly on management capability[14] and a shortage of managers with higher qualifications.

Examples of knowledge gaps in management 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 current and future 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 evidenced-based skills plan.

Examples of knowledge gaps in Workforce Skill Requirements include:

- Which parts of manufacturing are making the shift to higher skills and which are not?
- Is there a mismatch between the supplied and demanded labour skills in particular industries? e.g. companies have indicated a shortfall of device physics and composites engineering knowledge in Australia.
- What specific qualifications are manufacturers demanding and what common skills are manufacturers demanding across qualifications?

13 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%).

14 Bloom, Nick et al (2007) Management Practice and Productivity: Why They Matter, Management Matters. Available from: http://www.growingjobs.org/downloads/management_practice.pdf and McKinsey and Company (2009, 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 vocational and tertiary education service providers be more responsive to future economic needs?
- What commercial skills are most complementary for graduates with technical qualifications headed for the manufacturing sector?

Building better international linkages

As identified in AMGC's Sector Competitiveness Plan, some sub-industries in manufacturing currently underserve key export markets, including for both intermediate and finished goods. Australia also has among the weakest backward linkages[15] of any major economy.

Examples of knowledge gaps in International linkages include:

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

Driving Industry 4.0 uptake

Australian manufacturing has the opportunity to improve cost competitiveness and value differentiation by taking advantage of technologies transforming production processes and customer understanding. Many countries around the world are moving towards 'Industry 4.0' as a means of harnessing the opportunities afforded by cyber-physical production systems made up of smart machines, logistics systems and production facilities.

Examples of knowledge gaps in Industry 4.0 include:

- What are the opportunities Industry 4.0 has to offer Australian manufacturers? How can current trends in automation and data analysis be made relevant and accessible to the operations of Australian manufacturing firms, especially SMEs?
- What are the key actions that manufacturers can pursue to drive successful take up Industry 4.0 methods and technologies?
- How can Government initiatives, such as the Prime Minister's Taskforce on Industry 4.0, be made most relevant to the commercial opportunities and challenges facing manufacturers?

Leveraging Government procurement

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

Examples of knowledge gaps in leveraging Government procurement include:

- How can manufacturers be better appraised of upcoming procurement opportunities?
- How can Australia ensure a strong industry policy role in the forthcoming Australian defence capability acquisition?
- What are the best ways to create "spillover" benefits through the Government procurement process from industries with traditionally intensive procurement processes (e.g. defence) to other industries?
- How can value differentiation and integration into global supply chains be prioritised and incentivised through civil and defence procurement processes?

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

Australian Government
Department of Industry, Innovation and Science

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