

Submission

2016 National Research Infrastructure Roadmap Capability Issues Paper

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Question 1: Are there other capability areas that should be considered?

It is our view that advanced manufacturing needs to be designated as a separate field within the National Research Infrastructure Roadmap because of its critical importance to the future of the national economy.

Key areas of research under the banner of advanced manufacturing include: Additive Manufacturing, robotics, automation, nano and electronic devices, implantable materials, biomaterials, micro-fabrication, assistive technologies, design and materials manufacturing.

Advanced manufacturing is an indispensable part of Australia's future as a 'knowledge economy' and fundamental to our level of 'economic complexity'. This has been shown to be the driver of a nation's per capita income level and predictive of a nation's future growth. Differences in nations' performance are accounted for by differences in their economic complexity: the higher the complexity, the higher a nation's standard of living. To be globally competitive, Australian businesses need to develop highly customised goods and services, to be agile and responsive across multiple supply chains and excel in low volume, medium to high complexity, high value manufacturing. Agility, innovation and entrepreneurial SMEs are our keys to success, where previously scale- and cost-based mass production prevailed. New technologies and changes in international supply chains with innovative business models make successful competition on this new manufacturing model possible for Australia, provided key impediments and barriers are addressed.

RMIT's commitment to manufacturing over the last five years has been demonstrated through the investments in its Advanced Manufacturing Precinct (AMP) and Micro-Nano Manufacturing Facility (MNRF) in particular. These facilities comprise the latest macro and micro technologies for polymer and metal 3D printing together with high-end 5 axis CNC machining centres, are well connected with other local manufacturing research facilities and have built partnerships with international organisation like Fraunhofer to advance global research in advanced manufacturing.

AMP's focus is in the development and support of 'manufacturing innovation' in Australia, specifically through active support for research into and adoption of enabling technologies such as additive manufacturing, automated and assistive technologies and accelerated high value product development.

The take-up of new manufacturing processes and technologies in Australia is embryonic, and presents outstanding opportunities for Australian businesses to exploit high value markets of the future. Feedback from industry suggests detailed technology roadmaps highlight next generation of additive, automated and assistive technologies as critical to enabling Australia's innovative manufacturing sector to compete internationally. The global market for additive manufactured products alone is projected to be US\$130-\$250 billion by 2025. The Australian Industry Group (AI Group), Australian Manufacturing Technology Institute Limited (AMTIL) and Small Technologies Cluster (STC) provide an SME Portal to broad engagement with the manufacturing community. The Australian manufacturing SMEs are limited in capacity, scale and resources to engage enabling technologies and researchers. The RMIT Advanced Manufacturing Precinct engages SMEs in addressing and adopting new technologies and business models.

Question 2: Are these governance characteristics appropriate and are there other factors that should be considered for optimal governance for national research infrastructure.

In advanced manufacturing research infrastructure there needs to be sector wide co-ordination to ensure a national commitment and return on investment. Currently no such co-ordination exists and to this end we propose a national body –an Institute for Advanced Manufacturing that strategically plans, co-ordinates and oversees the national research effort and infrastructure funding across the advanced manufacturing sector that includes- SME's, large manufacturers and the research community generally.

Currently there are two national bodies that have responsibility for advanced manufacturing research- the Innovative Manufacturing CRC (IMCRC) and the Advanced Manufacturing Growth Centre (AMGC).

The IMCRC focus is to bring industry into clusters together with world-leading research capability and through the development and application of new materials, systems and technologies, creates new products, processes and business models. This enables industry to embrace the innovative manufacturing paradigm of high value, high knowledge, customer-specific products for the future.

The AMGC's focus is the active support for research into and adoption of enabling technologies such as additive manufacturing, automated and assistive technologies and accelerated high value product development, together with innovative business processes and models for industry transformation. Growth Centres will work to unlock commercial opportunities and drive innovation by building links between businesses and industry organisations and the science and research sector. They will assist Australian industry to better capitalise on the excellent research and development undertaken and scientific knowledge generated in Australia. The Growth Centre will boost the competitiveness, productivity and innovative capacity of Australia's Advanced Manufacturing sector by: identifying opportunities to reduce regulatory burden, increasing collaboration and commercialisation, improving capabilities to engage with international markets and global supply chains and enhancing management and workforce skills.

Both organisations, IMCRC and AMGC play a pivotal role in assisting the advanced manufacturing sector in R&D. Therefore it is our view that RMIT University and representatives from both these organisations together with the Australian Industry Group (AIG) and Australian Manufacturing Technology Institute Limited (AMTIL) should form a new entity 'Institute for Advanced Manufacturing', whose role shall be to co-ordinate research infrastructure nationally for advanced manufacturing.

Question 3: Should national research infrastructure investment assist with access to international facilities?

In order to compete globally within the advanced manufacturing context, there needs to be strong collaboration and research with access to international manufacturing facilities. To this end RMIT's Advance Manufacturing Precinct has developed major collaborations and partnerships with global centres in additive manufacturing such as Fraunhofer Institute for laser technology and Fraunhofer's Surface and Beam Technology, Germany, the Made in America Additive Centre, Youngstown, Ohio, Laser Centre North, Hamburg, Germany, Institute for Manufacturing, Cambridge, UK, to ensure research capability and capacity for the next generation of products, processes and researchers. National research infrastructure needs to underpin the advances in the sector and encourage further involvement in international facilities, where appropriate, and Australian domestic researchers are funded and have access to these international facilities. Some of these arrangements could build on existing partnerships that the AMP already has with international research institutes as above.

Question 4: What are the conditions or scenarios where access to international facilities should be prioritised over developing national facilities?

For advanced manufacturing-the value proposition where prioritisation should occur in access to international facilities is only when the research capability/expertise and or specialist infrastructure and equipment doesn't exist within a domestic research facility.

Question 5: Should research workforce skills be considered a research infrastructure issue?

The research workforce skills are central to advanced manufacturing capability and developing research capacity. If these skills are not developed domestically, then Australia's capacity to compete internationally is significantly compromised. The research capability (workforce skills) in advanced manufacturing goes hand in hand with the development of research infrastructure. It is therefore vital that Australian manufacturing industry is underpinned by the latest in advanced manufacturing infrastructure.

Question 6: How can national research infrastructure assist in training and skills development?

National research infrastructure assists the manufacturing sector to build skills and enables industry transformation. It is through industry driven research that manufacturers are given opportunities to adopt enabling technologies and skill-up the workforce. They do this by developing and applying for example additive manufacturing processes, which are enabled with automated assistive

technologies leading to the design and development of high value-added products. Thus advanced manufacturing competitiveness is a function of strategy, leadership, technological excellence and enterprise in the value chain. To have a major focus on advanced manufacturing research across the nation builds a multi-disciplinary set of skills that an advanced economy requires.

Additive Manufacturing or 3-D printing is now the fastest growing sector of manufacturing globally, growing at some 16% annually and reached \$3.5 billion in 2015. This is due to the many benefits it offers companies compared to traditional processes in terms of new product development, time to market, waste and product cost. The research and development for example in this field is in Design, Materials & Manufacturing and System Development.

There needs to be a structured methodology that is driven by market requirements and opportunities for the effective use of the research staff and resources, thus co-ordination becomes paramount in advanced manufacturing.

In 2011 RMIT University opened a new facility, the Advanced Manufacturing Precinct at its city campus to help meet the challenges facing Australia's manufacturing industry. In a short period of less than five years the AMP has:

- Over 1000 students going through the facility each year
- Over 20 companies involved each year in AMP programs and activities (including education, training, research)
- Over \$2 million research funded by industry national and international in total undertaking within AMP (and growing)
- Over 30 international delegation visits to AMP each year (including VP Boeing, VP Ford, VP COMAC, VP's of over 20 universities worldwide,
- Ministerial and high level Governmental visits to AMP as part of business development and bilateral collaborations (from Australia, China, Malaysia, Singapore, Hong Kong, etc.).
- Provides a vital hub for RMIT's industry engagement, which revolves around multiple industry sectors and complements the University's Design Hub.

The AMP is tasked with addressing both local industry training for engineers and technicians (**Skills and Training**) in new manufacturing industries and attracting businesses to Australia. With strategic support for the establishment of the AMP, the Victorian Government supported RMIT's vision for an advanced manufacturing precinct that combines research, design and additive manufacturing in one location, providing opportunities for innovation and product development, prototyping, rapid and additive manufacturing for the emerging advanced manufacturing sector in Victoria and global markets.

The RMIT Advanced Manufacturing Precinct plays a critical and vital role in helping industry and Victorian SMEs in particular, to develop new manufacturing capabilities.

RMIT is in various partnerships with peak industry bodies (AMTIL, Australian Defence Industries Network, Engineers Australia, Bio-Melbourne Network, CSIRO and others) has been organising and hosting industry forums in the AMP to raise awareness of new technologies and capabilities and contribute to transforming and building the capacity of the Australian industry using new digital design technologies, materials and additive manufacturing processes.

In addition to a range of partnerships and industry engagement projects with Victorian industries, RMIT is one of four Australian Universities that promotes and offers manufacturing as a discrete discipline in engineering. The AMP has strategic partnerships with the Victorian State Government and industry bodies that promote new and emerging advanced manufacturing technologies, research and training that assist the advanced manufacturing industry. Students participate in a variety of learning and training outcomes in the AMP in new and emerging technologies and research in advanced manufacturing. The focus of these new and emerging technologies for advanced manufacturing include:

- Design and CAD (digitisation, visualisation and modelling)
- 3D Printing of polymers, metal alloys and biological materials
- Development of new materials
- Laser additive manufacturing and repair of parts
- Advanced 5-axis machining
- Development of new and emerging additive technologies
- Process monitoring and control
- High value added manufacture of parts, e.g. medical implant design, manufacture and aerospace parts

Question 7: What responsibility should research institutions have in supporting the development of infrastructure ready researchers and technical specialists?

We believe academic institutions committed to teaching and research in advanced manufacturing should invest in the necessary infrastructure. A good example is the AMP, which represents a commitment to advanced manufacturing of some \$30M, comprising buildings (\$17M), facilities and equipment (\$13M entirely funded from RMIT internal resources). In addition, the staffing component comprising academics (12) and technical staff (6) represents an annual commitment of some \$3M. Other institutions such as Swinburne University, CSIRO, Monash University, University of Wollongong and others are similarly committed to advanced manufacturing sector. There does however need to be a national plan for co-ordination of new advanced manufacturing infrastructure in order to grow the manufacturing sector of the economy.

Question 12: Are there international or global models that represent best practice for national research infrastructure that could be considered?

In our view the best model for engagement in research and teaching in advanced manufacturing is the Fraunhofer model, where the technology readiness levels 4 to 7 are addressed. National co-ordination necessitates identifying which advanced manufacturing technologies are best brought to market for investment in Australia. A national Institute for Manufacturing could be charged with identifying these technology readiness levels and which new and emerging technologies are most appropriate for investment in the Australian economy.

Health and Medical Sciences

Question 15: Are the identified emerging directions and research infrastructure capabilities for Health and Medical Sciences right? Are there any missing or additional needed?

In the advanced manufacturing space and in particular 3D printing for biomedical engineering devices offers potentially many opportunities to value add in the field of design, materials engineering and science, with the possibility of developing new industries and supply chain models.

Advanced Physics, Chemistry, Mathematics and Materials

Question 22: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

To Partner projects that are directed towards the development of new technologies in 3D Printing, alloy and materials development and software tools for additive manufacturing.

Question 23: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Advanced Physics, Chemistry, Mathematics and Materials capability area?

Whilst some aspects of research in advanced manufacturing may be covered off in the roadmap for advanced Physics, Chemistry and Materials capability, it is critical that the research focus in the future is nationally co-ordinated through a 'National Manufacturing Institute' to prevent duplication. Please see below a Research Infrastructure Snapshot for advanced manufacturing

Other comments

If you believe that there are issues not addressed in this Issues Paper or the associated questions, please provide your comments under this heading noting the overall 20 page limit of submissions.

Table 1- Research Infrastructure Snapshot- Advanced Manufacturing

Now

Existing Capability Element	Existing Infrastructure
<ul style="list-style-type: none">• Digitisation• Additive manufacturing technologies• Design for manufacturing• Materials Science• Fabrication• Multi-axis CNC machining technologies	<ul style="list-style-type: none">• CSIRO Material Lab 22• RMIT's AMP• Uni Wollongong• RMIT Micro Nano research facility• Deakin Uni- Carbon Fibre• Swinburne Uni –Factories of the Future• Monash Uni- Additive Manufacturing• National Fibre Research Centre• Melbourne Centre for Nano Fabrication

Future

Emerging Trends	Examples of Potential new Industries
<ul style="list-style-type: none">• Industry 4.0- intelligent machines and robotics• Large scale additive manufacturing• Imaging, visualisation and digitisation• Distributed manufacturing e.g. biomedical implants• Metal deposition printing• Automation-Integrated manufacturing process and control	<ul style="list-style-type: none">• Development of new materials for additive manufacturing, eg. Powders, alloys and polymers• Software development for integrated advanced and additive manufacturing• Bio-Nano engineering?