National Robotics Strategy consultations

SUBMISSION – MAY 2023

Robotics and Industry 4.0 in Australia

Robotics and assistive technologies are an integral component of the technological transformation known as 'Industry 4.0'. Where previous phases of industrial upgrading focused on the automation of individual machines and processes, Industry 4.0 involves technological integration across a linked set of industrial activities.

Industry 4.0 practices call for automation and integration across an entire industrial system– at the factory, enterprise and perhaps even the global supply chain level.

Robotics is one of several technologies that comprise the Industry 4.0 suite. Smart sensors, additive manufacturing, robotics, mobile connectivity, human-machine interfaces, big data analytics, cloud computing and augmented/virtual reality all work together to enable integration and automation at the systems level. Each Industry 4.0 technology relies on inputs from the others to achieve it full impact – for example, autonomous robots require smart sensors linked via mobile connectivity.

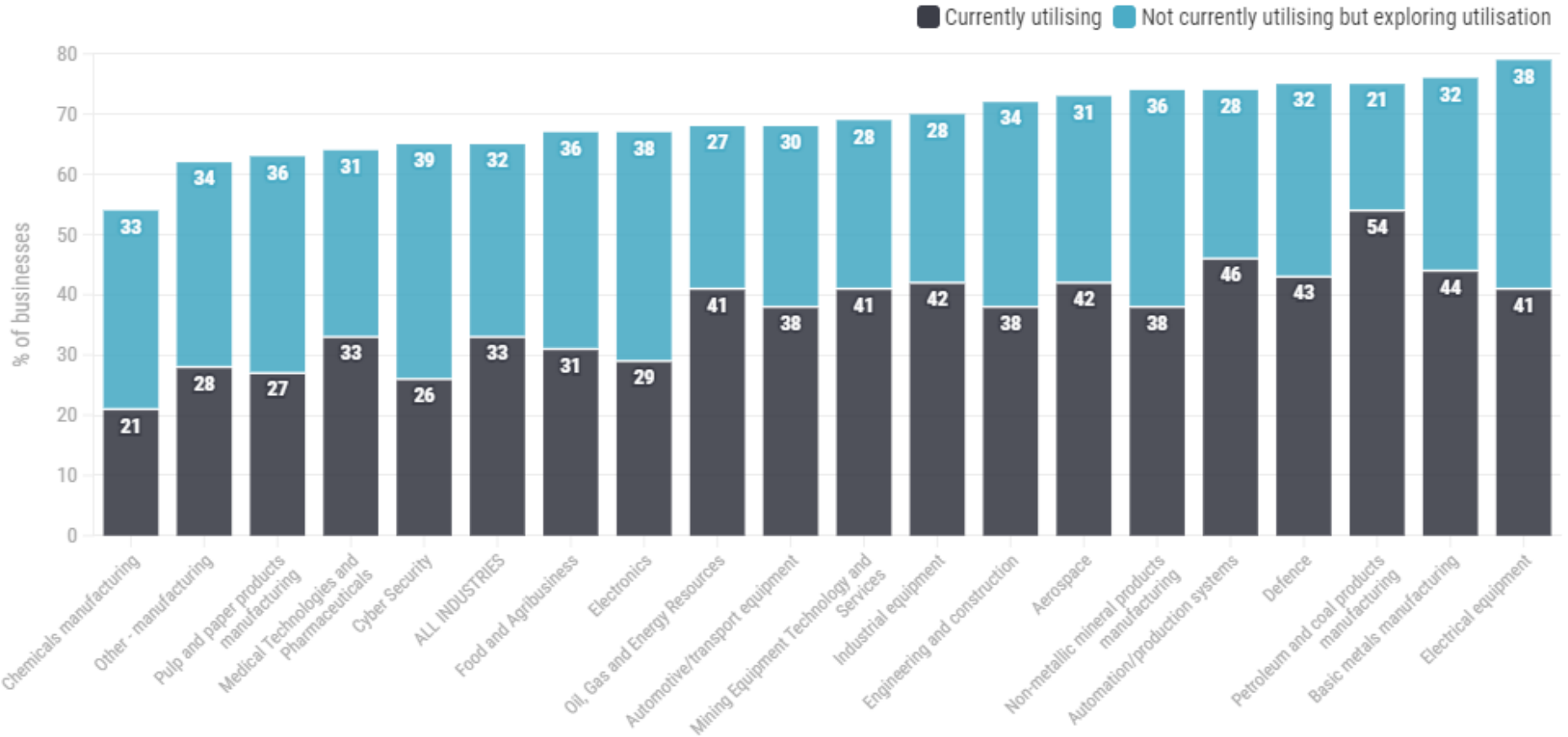
For this reason, the uptake of robotics in Australian industry is best analysed in the context of the broader implementation of Industry 4.0 practices and technologies.

Robotics has already found a place in Australian industry. Data on the uptake of robotics is available from Ai Group's futuremap® platform, a business diagnostic designed to assist manufacturers and related industries to adopt Industry 4.0 practices. Since its launch in 2018 by the Innovative Manufacturing Cooperative Research Centre (imcrc), nearly 1200 Australian businesses have completed the futuremap® tool.

Utilising the data gathered through futuremap®, Figure 1 below provides an assessment of utilisation rates for robotics and assistive technologies in the manufacturing and related industrial sectors. It shows that:

- 33% of Australian industrial businesses were using robotics and assistive technologies at the time they completed futuremap®,
- 32% of businesses were not currently utilising robotics, but were exploring its use.
- Robotics utilisation rates vary between subsectors – from 21% in chemicals to 54% in petroleum and coal – but 'exploration' is fairly uniform (around 30%) across industries.
- Robotics use is generally higher in industries with greater human involvement in material flows, where robots enable more efficient and safer materials handling.
- Robotics use is not necessarily correlated with the technology content of the final product. Some less technology intensive products (such as basic metals manufacturing and coal products) have above average rates of robotics use.

Figure 1: Utilisation of robotics and assistive technologies in Australian industry



Source: Ai Group imcrc futuremap

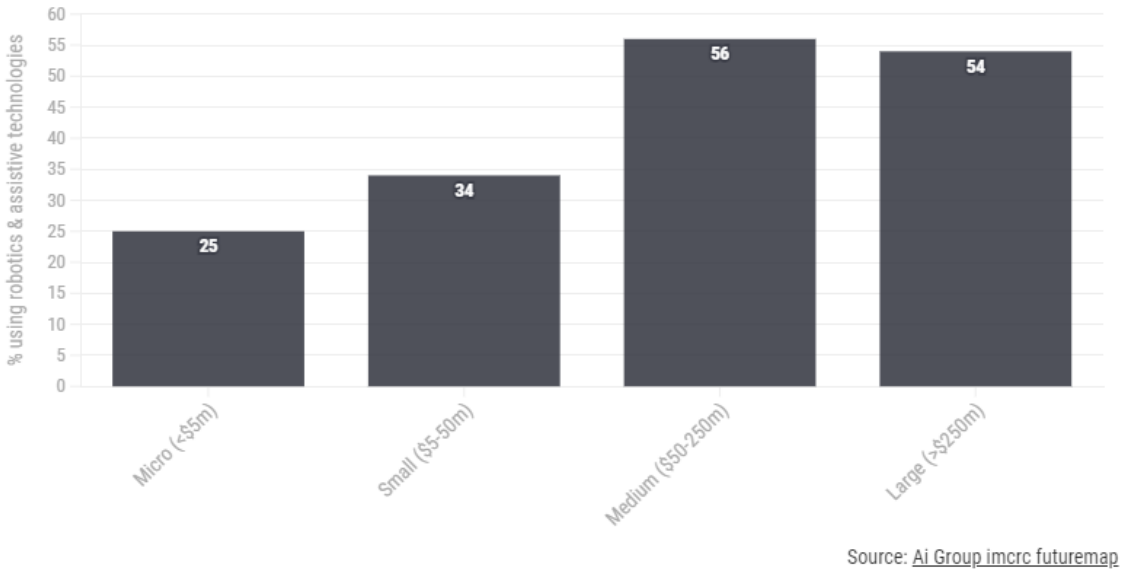
This suggests that while robotics has already found a foothold in Australian industry, there is considerable room for growth. For every business currently using robotics and assistive technologies, there is another business which is exploring use.

What factors account for the differential uptake of robotics across industry? Using Ai Group futuremap® data, we can identify three main correlates of robotics utilisation in Australia:

- **Larger business size:** Robotics use increases with business size (Figure 2). Only 25% of micro-businesses use robotics and assistive technologies, with the figure doubling to over half amongst medium and large industrial enterprises. This reflects the upfront cost robotic technologies, which requires minimum scales to achieve efficiency and capital resources to cover initial acquisition costs.
- **Implementation of Industry 4.0 practices:** Businesses who have implemented common Industry 4.0 practices utilise robotics at more than double the rate as those which have not (Figure 3). This reflects the fact that the value of robotics is maximised in a business which has whole-of-process enterprise integration systems in place, which can be used to control and optimise robot performance.
- **Adoption of enabling technologies**: Businesses who have adopted enabling technologies are around twice as likely to utilise robotics as those which have not (Figure 4). This reflects the dependence of robotics on sensors, data analytics and software management systems that provide the network effects necessary for environmental awareness and autonomous operation.

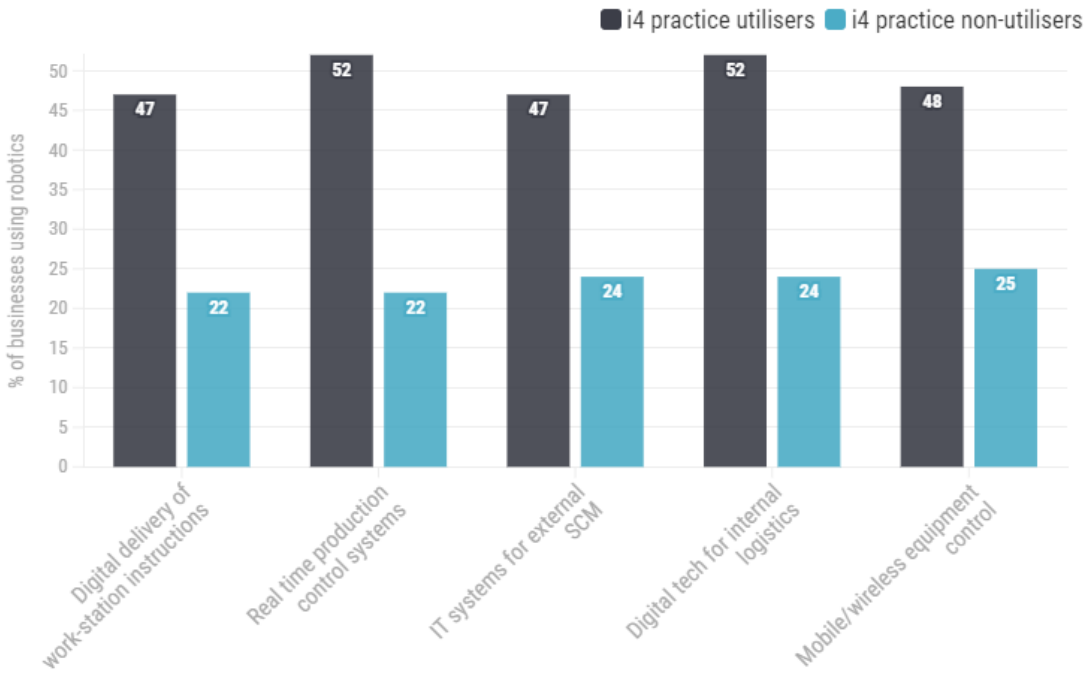
This data reveals that robotics is not a standalone technology, but an integral component of the Industry 4.0 suite. Robotics adoption 'makes sense' when it is embedded in a broader set of digital-driven industrial managements practices. To improve the uptake of robotics technology by the one-in-three businesses currently exploring it, policy needs to target the broader adoption of Industry 4.0 practices.

Figure 2: Robotics use in industry by business size



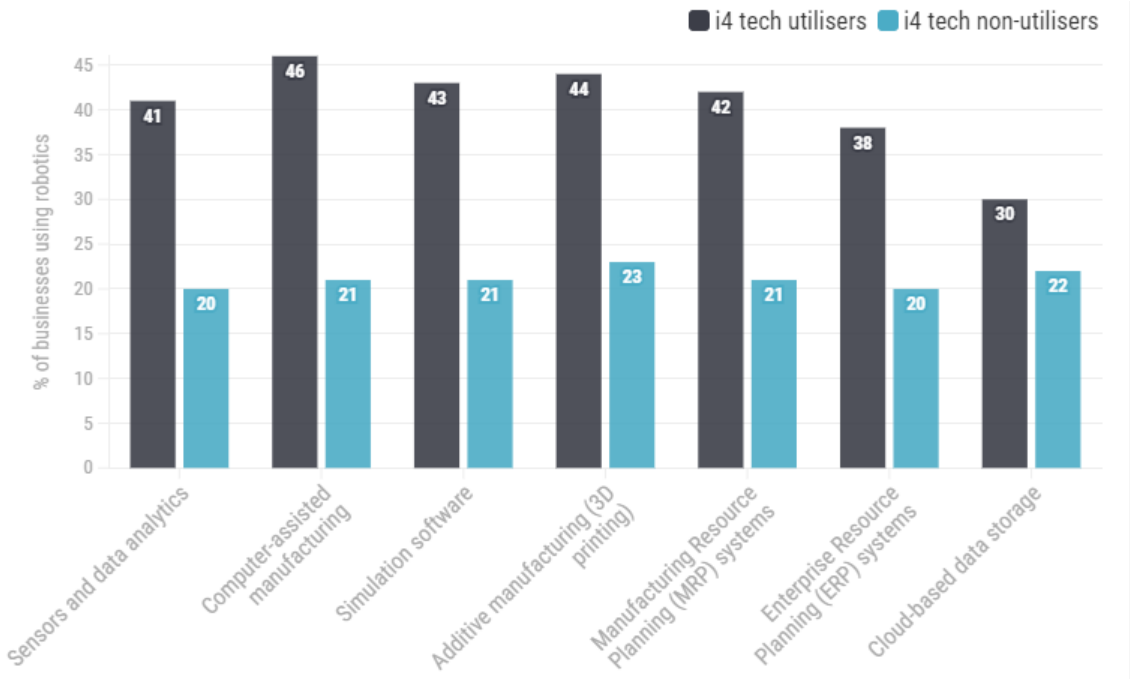
Source: Ai Group imcrc futuremap

Figure 3: Robotics use by businesses with Industry 4.0 practices



Source: Ai Group imcrc futuremap

Figure 4: Robotics use by businesses with Industry 4.0 enabling technologies



Source: Ai Group imcrc futuremap

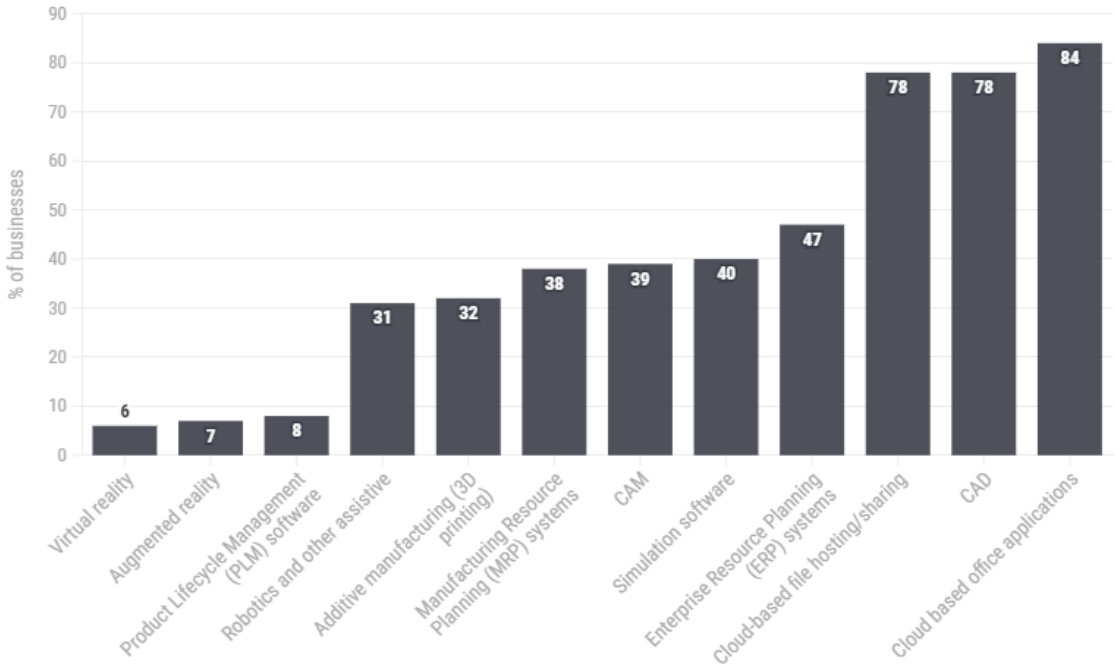
Advancing Industry 4.0 and robotics in industry

Well before COVID-19, Australian industry was evolving to adopt Industry 4.0 practices and technologies. But the pandemic has also highlighted how interconnected many businesses are and digital technologies has been an enabler for many businesses to remain open and sustainable. This environment presents an opportunity for industry to emerge more globally competitive by taking fuller advantage of Industry 4.0 and digitalisation, where these can play critical parts of Australia's technology led recovery.

However, the uptake of Industry 4.0 technologies remains uneven in Australian industry. According to Ai Group futuremap data:

- Adoption of mature digital technologies – such as cloud-based applications, cloud data storage and computer-assisted design – is well advanced, and now in use by the majority of industrial businesses.
- Adoption of industrial process technologies – such as ERP/MRP systems, additive manufacturing, simulation and CAM – is emerging. Between one third and one half of industrial businesses utilise these technologies.
- Adoption of new digital technologies – augmented or virtual reality, and full product-lifecycle management – remains embryonic. Only a small minority of industrial businesses are yet to bring these online.

Figure 5: Adoption of Industry 4.0 enabling technologies



Source: Ai Group imcrc futuremap

However, the implementation of technologies only forms part of the Industry 4.0 paradigm. In the policy context, other areas for action require building a policy environment that incentivises investment in innovation and R&D; lowering regulatory barriers for companies to compete

globally; improving digital transition in industry and the economy more broadly; and developing the appropriate skills and talent required for Industry 4.0 transitions.

Regulation is an important area that could make or break the growth of an industry at its early stages of development. The extent to which industry is regulated associated with new and emerging technologies can act as an investment barrier and diminish our attractiveness relative to other jurisdictions. There should be careful consideration of any new forms of regulation against global best practice approaches and the extent of industry support overseas.

Many SMEs are progressing Industry 4.0 strategies without using the label. Instead, their primary objectives are to implement new approaches to enable them to manage their operations, become more energy efficient, improve productivity, lower costs or meet new demands from customers.

As expected, such steps are often neither perfect nor easy and present successes along with their own practical challenges. The following were some anecdotal feedback that we have come across with respect to Industry 4.0:

- **Changing organisational mindsets:** Getting the organisation to appreciate the impact of digitalisation and automation, addressing fears regarding "job loss" to one of "job quality improvement"
- **Leadership:** Technology helps leaders focus on leading yet also highlights where they do not; need for people managers and critical thinkers, not traditional process leaders; and capability required in change management.
- **Justifying expenditure:** Some businesses with digitalisation strategies had difficulties justifying expenditure on particular Industry 4.0 initiatives.
- **Incremental success:** Some businesses started small – rather than changing everything at once – to demonstrate success and sought approval afterwards.
- **Trusting and adapting to technology:** Getting traditional workers to trust data more than their experience and intuition; getting people used to AI; need for a technology adaptive culture.
- **Perceptions:** No matter how much businesses were doing and how established they were, all thought they were beginners on Industry 4.0.
- **Data use:** Lots of data were being collected already but some businesses were not sure what to do with it all; finding the right people to turn the collected data into insights; people have technical ability but not the mindset to maximise the use of data; and uncertainty as to who controls or owns the data.
- **Interoperability issues:** System integration was a challenge; and middleware was used to overcome different standards and proprietary systems.
- **Supplier capability:** A major constraint was matching suppliers with the capability required by the company; and if Industry 4.0 enables companies to increase just-in-time production, especially globally, a model will be required for addressing delays in physical delivery.

We recommend:

- Australia needs to move beyond a narrow "technology uptake" focus in policy, to more broadly target the suite of practices associated with robotics and Industry 4.0.
- Businesses which are exploring robotics, but do not have the required suite of Industry 4.0 enablers in place, should be offered support across a range of technologies and practices to update their manufacturing practices.
- Robotics technologies need to be taken up across businesses of all sizes, including SMEs. Support measures for robotics need to be appropriately scaled and accessible for SME utilisation.
- Regulations for digitalisation and automation should be designed in a manner that encourages further adoption and provides the stability required for investment attractiveness.
- Digitalisation is a key enabling technology for Industry 4.0 and robotics, which are founded on digital tools. Efforts to support digitalisation, both economy-wide and within industry, will promote Industry 4.0 and robotics.

Research and development (R&D) support

R&D is relevant to robotics and Industry 4.0 in two distinct but complementary ways. It is required to develop robotics technologies, particularly those with application in Australia's distinct industrial landscape (such as mine automation, remote sensing and autonomous vehicles). R&D is also involved when integrating robotics into industrial value chains, as part of the broader Industry 4.0 transformations required.

Australia is recognised globally for its high-quality research, and despite only having 0.3% of the world's population, we've contributed to over 4% of world research publications. However, R&D is too costly for Australian industrial SMEs, and there is not enough support for local participation, with the current R&D tax incentive failing to encourage more research commitment. Similarly, businesses have indicated there are challenges to collaborating with Australian universities given cultural differences. These differences include overvalue of IP by universities and the difference in pace between a faster moving private sector and a traditionally slower moving research process.

We recommend:

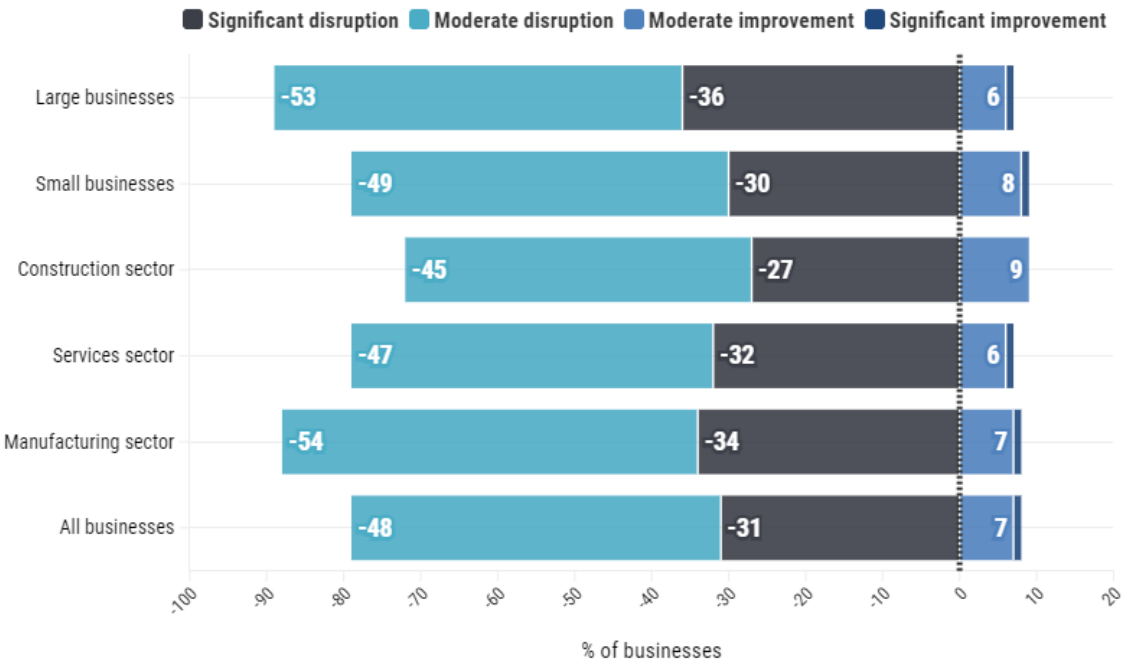
- R&D is involved in both the *development* of robotics technologies, and their implementation into existing industrial processes and facilities. Support for robotics R&D should target both the developers and end-users of robotics technologies, and not just the former.
- Additional Government support for R&D, beyond the R&D tax incentive, should also align with the broader Industry 4.0 agenda. While it will be beneficial to target robotics itself, it will be equally important to support R&D in the enabling technologies needed for greater robotics uptake.
- Australia should consider its strengths and invest in them, while deprioritising areas that are likely to be more successful offshore. We are likely to be competitive in

robotics fields which are functionally aligned to areas of industrial scale and competitiveness in the Australian economy.

Supply chains

The COVID-19 pandemic has exposed weaknesses in the operations of global and domestic supply chains. These include the extended interruption of global supply, the weakness of relying on human-centric systems to deliver on time, and exposure to shortages of 'critical goods' needed by industry. During 2022, 79% of Australian businesses experienced supply chain disruptions, with effects felt across both large and small businesses and all branches of industry (Figure 6).

Figure 6: Supply chain disruptions affecting Australian business in 2022



Source: Ai Group CEO Survey 2023

Supply chain disruptions are especially pertinent for robotics and Industry 4.0. These technologies require specialised physical components and intangible assets, some of which Australia will be required to import. Several Industry 4.0 enabling technologies, such as MRP and ERP systems, also rely on integration with global supply chain data sources. Supply chain disruptions will particularly affect businesses whose Industry 4.0 transformation includes robotics and its enabling technologies.

We recommend:

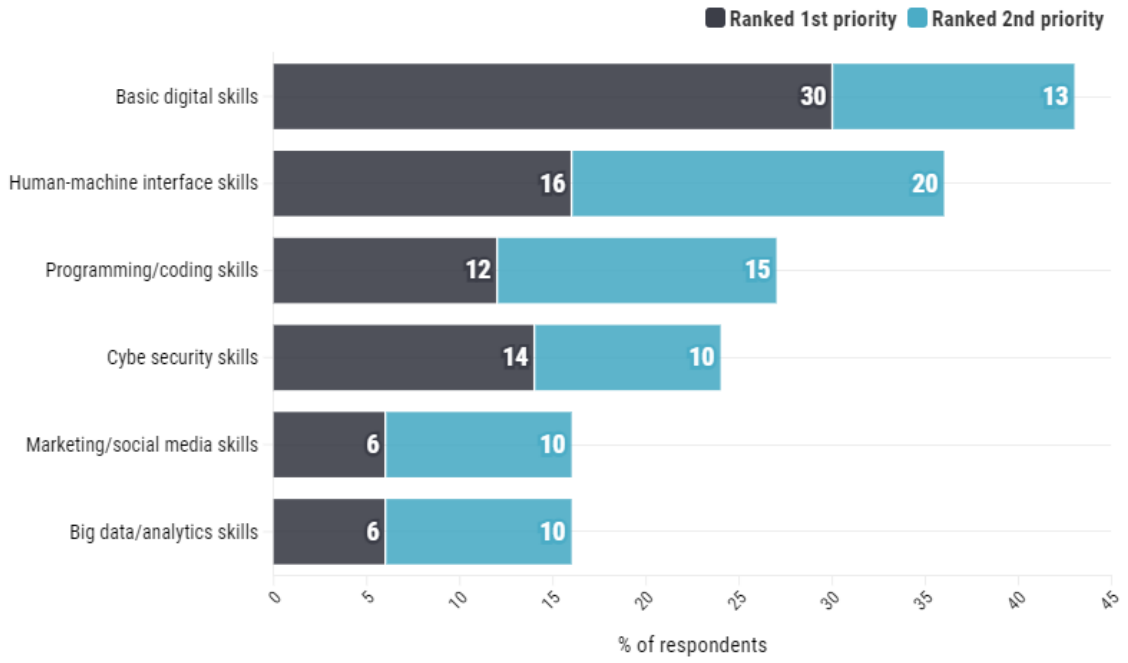
- Government support to shore up our industrial supply chains and their ability to meet the needs of Industry 4.0 and robotics users. The Government must consider how it encourages the development of supply chain skills and investment into supply chain technology and operations.

- The creation of a regulatory regime that is aligned to Industry 4.0 and robotics needs, while reducing compliance costs for businesses.
- Drive the adoption of an end-to-end integrated supply chain management system that provides industry-wide and business-level efficiencies. This might include Artificial Intelligence Blockchain, integrated ERP, and other digital supply chain technologies.
- Digital trade and supply chain tools enable us to predict and prepare for supply chain disruptions, rather than simply reacting to them. The digitalisation of trade, such as paperless trading and e-certificates, will help improve supply chain resilience.

Digital skills and training needs for robotics and Industry 4.0

Skill needs in advanced manufacturing are broad and deep. The sector needs a mix of technical/specialist, generic and leadership skills. However, robotics and Industry 4.0 will increase the importance of digital skills within the industrial skills mix. Digital connections are the essence of Industry 4.0, and skills in the digital space will be essential for not just specialist roles but the entire industrial workforce.

Figure 7: Digital skills needs of Australian manufacturers



Source: Ai Group Skills Survey 2022

In the Ai Group Skills Survey 2022, we asked Australian manufacturers regarding their current priorities for digital skills needs in the workforce (Figure 7). The results speak to the prominence of Industry 4.0 concerns. The top ranked priority was basic digital skills, which will be required in every role for successful systems integration. Human-machine interface skills – the ability to work effectively, productively and safely with robotics – ranked a close second. The programming and coding skills needed for Industry 4.0 integration also ranked highly.

The successful implementation of robotics also requires two distinct but inter-related skills bases. One are 'mechantronic' skills involved in the design, implementation and integration of

robotics technologies. A second are robotics operational skills, required in workforces that make use of robots, that concern their safe and efficient utilisation in industry. While developing both are equally important to the national robotics skills ecosystem, the former is often prioritised in policy while the latter receives less attention.

Ai Group has developed a typology of the skills seen as vital to the future workforce capability for Industry 4.0. Our skills list is gleaned from discussions with members, and is consistent with a range of reports that examine the manufacturing sector's future skill needs. These skills form the basis for transforming manufacturers to high-value advanced manufacturing operators geared for future digitalised scenarios.

Table 1: A typology of digital skills for Australian industry

Leadership skills	Technical skills	Generic/human skills
Developing digital-at-the-core vision, strategy and risk Mapping technology architectures for manufacturing Decision-making using real-time data Analysing and interpreting data for informed decisions Aligning a rapidly up-skilled workforce with strategy Building intelligent, adaptive and agile operations Collaborating internally and externally to create new value Moving to sustainable, circular business models Ensuring safety awareness through protocols and regulations	Complex data engineering, architecture, and analytics AI/machine learning/mobile machinery Blockchain technology Cloud computing Cyber security Augmented Reality/Virtual Reality Logistics/supply chain management; sourcing and procurement; asset management Environmental monitoring; energy management use and procurement Advanced maintenance and diagnostics Remote operations Marketing and customer experience analysis	Cross-functional teaming Creativity Analytical thinking Complex problem solving /trouble shooting in production Adaptability Active learning - learning new skills quickly Resilience

Most Australian universities that offer engineering training include robotics in their qualifications. However, as technology evolves at increasingly rapid rates, there is a need to ensure that those studying robotics have access to the workplaces that are using the most up-to-date technology. Work-integrated learning should become the norm for university programs in robotics and related digital engineering fields. Models such as higher-level or degree-level apprenticeships that include robotics will provide a VET complement to university-level robotics training.

There are training gaps for workers who might be expected to program, or maintain or work alongside robots. In the VET sector there are training products that have been developed for robots and robotics, however the coverage to date is far from comprehensive. As an example, in the manufacturing and engineering sector, there are existing robotics training options for para-professional (technicians), but there is little for tradespeople or production workers. Where training products have been developed, there is often a lack of training resources and trainers to deliver the training[1].

Some organisations are addressing the gap by developing micro-credentials or short courses to train workers to program or work alongside robots. An investment in the development of nationally available training resources suitable for people who might be expected to program robots and for people who work alongside robots would help workers develop their skills.

We recommend:

- Ensuring Industry 4.0 and robotics skill needs are mapped over the short, medium and long term, through the new Jobs and Skills Australia and Jobs and Skills Councils, to inform skills planning
- Expanding the apprenticeship system to include higher qualification levels, to meet the need for higher level technology skills associated with Industry 4.0 and robotics
- Consider how Industry 4.0 and robotics align to and is incorporated in existing skills pathways, particularly at the trades level
- Improving digital skills across the board by formalising digital literacy as part of postschool education and training and upskilling older workers
- Creating a culture of lifelong learning by building an education and training system that can rapidly and flexibly upskill existing workers through short, stackable training options and fluid credentials.
- Facilitating applied, employment-based learning typified by apprenticeships, traineeships and cadetships, as well as work integrated learning.

Defining robotics holistically within the industrial context

The National Robotics Strategy discussion paper proposes a definition of robotics based on four essential characteristics: sensing, movement, energy and intelligence. The discussion paper also indicates that the broader concept of automation will be considered in the strategy where automation is enabled by robots.

Feedback from Ai Group members that are robotics users suggests this definition is too restrictive to fully capture the factors associated with robotics utilisation in industry.

[1] For example, there are two units of competency that have been developed to cover programming and configuring robotics (MEM07039 and MEM29009), but at time of writing no training provider is offering training for those units, and there are no training materials currently available.

In the context of industrial robotics, robots are simply one of many technologies involved in automation. Automation technologies exist on a continuum of sophistication: from basic machinery that reduces manual handling at the simplest end, through to robotics at the most complex. A robot is simply an automation technologies that possess sensing, movement, energy and intelligence.

Using these four criteria to demarcate robotics from broader automation is therefore somewhat artificial and distortive. An automation technology that possessed two or three of the characteristics may not defintionally qualify as a "robot". However, it would still require many of the same set of capabilities to develop and implement, and would still bring many of the benefits of robotics. Indeed, many Australian companies are likely to use simpler "near-robots" first before using "full robots" later.

A policy definition which insists on these four characteristics is likely to exclude many robotics capabilities and applications which are pertinent to industrial applications in Australia.

Similarly, a policy scope which considers automation *where it is enabled by robots* fails to recognise the reverse relationship – how automation itself enables robotics. As noted in prior sections, industrial robotics relies on a range of enabling Industry 4.0 technologies and practices. Without these enabling factors in place, robots cannot be successfully implemented in industry.

Indeed, it is often the degree of automation which constrains robotics uptake. A business which has already implemented Industry 4.0 automation technologies – such as wireless communications, smart sensors, and big data – will have much lower learning and cost curves when adopting robotics. If policy intends to encourage the uptake of robotics, it also needs to consider how to support automation in non-robotics using industry as a key robotics enabler.

We recommend:

- The National Robotics Strategy adopts an open approach to defining robotics, which recognises it as part of a continuum of automation technologies
- Promoting the uptake of wide range of robotics technologies in Australia, which may include some 'near-robots' that possess some but not all of the characteristics of sensing, movement, energy and intelligence.
- Conceptualising a two-way relationship between robotics and automation, where robotics is both *enabled by* and is *an enabler of* automation and Industry 4.0.

About the Australian Industry Group

The Australian Industry Group (Ai Group®) is a peak employer organisation representing traditional, innovative and emerging industry sectors. We are a truly national organisation which has been supporting businesses across Australia for more than 140 years.

Ai Group is genuinely representative of Australian industry. Together with partner organisations we represent the interests of more than 60,000 businesses employing more than 1 million staff. Our members are small and large businesses in sectors including manufacturing, construction, engineering, transport & logistics, labour hire, mining services, the defence industry, civil airlines and ICT.

Our vision is for a thriving industry and a prosperous community. We offer our membership strong advocacy and an effective voice at all levels of government underpinned by our respected position of policy leadership and political non-partisanship.

With more than 250 staff and networks of relationships that extend beyond borders (domestic and international) we have the resources and the expertise to meet the changing needs of our membership. We provide the practical information, advice and assistance you need to run your business. Our deep experience of industrial relations and workplace law positions Ai Group as Australia's leading industrial advocate.

We listen and we support our members in facing their challenges by remaining at the cutting edge of policy debate and legislative change. We provide solution-driven advice to address business opportunities and risks.

Australian Industry Group contacts for this submission

Louise McGrath – Head of Industry Development and Policy
Louise.McGrath@aigroup.com.au

Dr Jeffrey Wilson – Director of Research and Economics
Jeffrey.Wilson@aigroup.com.au

www.aigroup.com.au