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## Robotics Australia Group Ltd submission to National Robotics Strategy

Robotics Australia Group is the peak body representing the robotics and robotics-related technology sector. Our goal is to build a sustainable robotics industry in Australia. We have consulted with our network of more than 5,000 to ensure the Australian robotics ecosystem's broad range of views are represented in this submission. Field and Service Robotics will impact every sector of the Australian economy and will help Australia to diversify and modernise its economy, as well as doing social and environmental good. By creating and adopting robotics technologies, Australians will have highly paid, safe, and fulfilling jobs in the near future. The application of robotics and automation will help to: lift economic productivity, protect our environment, provide equity in access to services for our rural and remote communities, reduce the cost of healthcare, accelerate decarbonisation, and reshore jobs and manufacturing back to Australia to maintain our living standards. But only if we *invest* in the talent and technologies we are developing in robotics, here in Australia. ***We must be ambitious and seek to build homegrown global companies that export robotics and AI technologies to the world.***

Research has shown that the tech sector contributes \$167 billion annually to the Australian economy and employs 861,000 Australians<sup>1</sup>. As outlined in the Discussion Paper, robotics in Australia is a fledgling but growing industry capable of enormous impact, currently thought to be worth more than \$18bn in revenue to the Australian economy, employing more than 50,000 and comprising more than 1,000 companies with robotics capability. Critically, \$92 billion of the tech sector's annual GDP contribution is generated in industries outside of the direct tech sector. On top of this, business as usual applications of field robotics are emerging to support the safety and productivity improvement needs of the Mining and Construction industries, which contribute 21.9% of Australia's economic output<sup>2</sup> generating \$97.2bn GDP<sup>3</sup>. The robotics opportunity highlights this dynamic, as the robotics industry generates significant value through direct creation of robotics-related products and services as well as providing safety and productivity benefits to the sectors that adopt robotics and automation.

Having recently developed and published the 2022 Robotics Roadmap for Australia, an extension of the ground-breaking 2018 Robotics Roadmap, Robotics Australia Group welcomes the Government's timely development of a related National Robotics Strategy to promote the responsible production and adoption of robotics, AI and automation technologies.

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<sup>1</sup> *The economic contribution of Australia's tech sector 2021*, Tech Council Australia.

<sup>2</sup> Economic snapshot <https://www.rba.gov.au/education/resources/snapshots/economy-composition-snapshot/>

<sup>3</sup> <https://tradingeconomics.com/australia/indicators>

## Definitions

Robotics Australia Group supports the definitions as they stand but also suggests a more fulsome inclusion of AI in the definition as per the Kingston AI Group submission:

*Artificial intelligence (AI) is a field of computer science and engineering that focuses on the development of intelligent machines that can perform tasks that typically require human intelligence, such as recognising speech, understanding natural language, making decisions, and solving complex problems. Artificial Intelligence is critical for enabling robots and autonomous systems to interact with the physical world in intelligent and adaptive ways. By incorporating AI algorithms and techniques, robots can be programmed to navigate through complex environments, recognise objects, learn from experience, and adapt to changing situations.*

Artificial Intelligence is the enabling technology that delivers autonomy and allows a programmable machine to make sense of its dynamic surroundings and to respond in a sophisticated and sensible way, a key feature of most service robots in which Australia specialises. For this reason we invariably highlight opportunities specifically in the AI space that support robotics.

## Australia's Robotics Opportunity

**VISION** Establish Australia as a global leader (Top 10 as measured by export value) in the supply of trustworthy robotics and AI products and services by 2030, with the robotics and AI industry integral to a prosperous, fair, and inclusive society.

### Actions

- Add 'Robotics and Artificial Intelligence' to the Australian Research Council Science and Research Priorities with dedicated funding.
- Update the Australian and New Zealand Standard Industry Classification scheme to enable the measurement and tracking of Australia's technology sector - with specific categories for robotics and robotics-related technologies (notably AI). Release dedicated statistics on Australia's technology sector.
- Invest in Robotics and AI infrastructure such as data centres, cloud computing, high-speed networks, rapid prototyping, high-fidelity experimental testbeds with regulatory approvals in place, as well as environmental sensing infrastructure to support the development and deployment of Robotics and AI technologies.
- Support networks between national and international research organisations, e.g., supporting Australian researchers to integrate into EU-ERC, NSF, JSPS funding.
- Also support stronger linkages between research and industry, and collaborate with other countries to promote the development and adoption of AI technologies that can be applied to robotics, and to reassert Australia as a global leader in this field.
- Increased investment, effort, education and incentives to "pull" emerging technology into industry use, supporting both commercialisation of our world-leading research capabilities as well as uptake by industry.
- Reduce barriers to movement of people between academia and industry by

encouraging industry professorships and addressing the superannuation penalty academics face to move into industry.

- Map Australia's Robotics and AI supply chain to identify where companies have access to Australian products, e.g., dc motors, semi-conductors, etc.
- Proactive measures to encourage relevant multinationals to locate within clusters of Robotics and AI activity in Australia, supporting the local ecosystem, and developing a pipeline for graduates (beyond SMEs).
- Develop new co-ventures focused on key verticals where Australia has specialised sectoral strengths in robotics systems e.g., mining, energy (particularly renewables), construction, defence, infrastructure, agriculture, aerospace/space, logistics/transport, emergency/disaster response.
- Establish an information-exchange platform and agreed market development codes between Australian and overseas industry and investors to explore market opportunities, enhance trade and stimulate two-way investment.
- Incentivise expat Australians to invest back into Australian start-ups and to locate a research and development office in Australia to leverage the talent and skills located here.
- Develop economic policy initiatives that appropriately distribute the benefits of technology to directly combat income inequality.

## The Robotics Opportunity for Australia

Australia's small population and the fact that we inhabit a large continent with a challenging climate and unique environment means Australians have had to become very good at field robotics. As we have relatively few people inhabiting a vast landmass, we have thousands of kilometres of infrastructure to inspect and maintain - bridges, roads, railways, powerlines, and pipelines - and we simply do not have enough people to do the work. For this reason, and to keep people safe from harm, Australia has become adept at developing technologies that are robust and can reliably work in extreme environments; that have low power requirements; and that can operate with limited communications - especially in GPS-denied environments such as underground and underwater. For example, Australia was one of the first countries in the world to automate its ports and also the first country in the world to automate many of its mines<sup>4</sup>.

Field robotics is a particular opportunity for Australia as we have both the domain expertise, the local market and the potential for high growth through export to global markets. The Australian Government made early investments in field robotics via the Australian Centre for Field Robotics, CSIRO's Robotics and Autonomous Systems group and the Australian Centre for Robotic Vision. These initiatives have helped foster industry partnerships and drive innovation in the sector. Australia was a recognised world leader in field robotics<sup>5</sup> until progressive defunding of the sector led to other nations catching up. However, it is not too late to capitalise on our first mover advantage. As a horizontal industry sector, the vertical sectors where field robotics have the most enabling and transforming impact include: mining, energy (particularly renewables), construction, defence, infrastructure, agriculture, aerospace/space, logistics/transport, emergency/disaster response and the services sector such as real estate, sports and healthcare (incl. aged care). It should also be recognised that ALL sectors of the Australian economy will be impacted by robotics and automation and we *must* prepare. The National Strategy should therefore address all sectors.

<sup>4</sup> Robotics Roadmap for Australia 2022; Robotics Australia Group, <https://roboausnet.com.au/robotics-roadmap/>

<sup>5</sup> Is Australian Robotics Making a Comeback? 2023 Asian Robotics Review <https://asianroboticsreview.com/home645-html>

## Measuring Growth and Success

Like many parts of Australia's tech sector, robotics is not recognised as an industry in the Australian and New Zealand Standard Industrial Classification scheme (ANZSIC), used by the Australian Bureau of Statistics to collect industry relevant data for benchmarking purposes. As robotics is not recognised as an industry in its own right, it is difficult to obtain consistent measurements of the size of the industry (how many companies), how many people it employs, how much revenue it generates and how much it contributes to Australia's export income. Creating benchmarks to be able to measure the growth and success of robotics on an ongoing basis is important.

To measure the growth and success of Robotics in Australia we should consider adopting the following targets (and measures).

<b><i>National Capability measures</i></b>
<ul style="list-style-type: none"> <li>• Develop Robotics and AI as a key industry: expand our sovereign Robotics and AI industry to be worth AUD 25 billion by 2026, and AUD 50 billion by 2030.</li> <li>• Robotics and AI Venture Capital Investment of \$5b per annum by 2025, with Australia increasing its venture capital per capita to at least \$500 per person by 2030<sup>6</sup>.</li> <li>• Number of pure play Robotics companies 500 by 2027 and number of pure play AI companies 1,000 by 2027.</li> <li>• Number of Series A funding to robotics and AI start-ups, 5 robotics start-ups per year by 2025 and 10 AI start-ups per year by 2025.</li> <li>• Number of Robotics Unicorns 1 by 2025, 4 by 2027, 8 by 2032 and the number of AI Unicorns 2 by 2025, 8 by 2027, 16 by 2032 or develop a measure of # of companies above a value cap of \$200m and work to increase this number.</li> <li>• 5% of Australia's largest tech companies are hardware/software companies with a further 10% of Australia's largest tech companies to be AI-led by 2030.</li> <li>• Increase in export value of Robotics and AI to Australian economy by 30% by 2030 above current benchmark data.</li> <li>• Raise the level of Australian research and development as a percentage of GDP to 3% by 2030, with dedicated investment in Robotics and AI of \$50 million per annum by 2025.</li> </ul>
<b><i>Trust, Inclusions and Responsible Development and Use measures</i></b>
<ul style="list-style-type: none"> <li>• Increase trust in Robotics and AI to 90% across Australia by 2030 (as measured by sentiment analysis).</li> <li>• Increase Robotics and AI literacy by 20% by 2030 compared to current levels (benchmarked according to understanding of what the technology is and how it is applied).</li> </ul>
<b><i>Skills and Diversity measures</i></b>

<sup>6</sup> <https://news.crunchbase.com/startups/countries-most-startup-investment/>

- Train and educate 10,000 Robotics and AI specialists by 2026, including researchers, engineers, technicians and entrepreneurs.
- Increase Robotics and AI graduates to 20,000 per year by 2026 and 40,000 per year by 2030 (as measured by graduates from relevant university degree programs).
- Increase the number of people with trade qualifications to support intelligent machines such as mechanical and electrical trades (esp. those specialising in control) by at least 10% through VET programs.
- Develop a Robotics and AI Specialist Workforce of 100,000 by 2026 using mechanisms such as skilled migration (as measured by identification as specialist workers within the tech sector).
- Support upskilling with 20 high quality open online universally recognised Robotics and AI courses and microcredentials by 2030.
- Improve diversity of graduates and workforce to 30% women in technical roles by 2030 and with representative indigenous participation.
- Gather data on 4IR training such as type, engagement, utility, rate of completion.

### **Adoption measures**

- Increase uptake of Robotics and AI by Australian companies to 30% by 2030 to be measured by ABS (like innovation).
- Industrial robot population density of 500 by 2030 to aid 'high value add' manufacturing.
- Develop a measure of Field and Service robot intensity and set a target based on benchmark data.
- Increase in multifactor productivity in Australia to 2.5% by 2030 and 2.75% by 2040 attributable to AI-enabled robotics and automation initiatives.

### **Anything else to be considered in Vision?**

Australia's Vision should also focus on ensuring current and future workforces are upskilled to maximise the future opportunities from robotics and AI. The Vision should align with the UN's Sustainable Development Goals and seek to integrate circular economy and sustainability principles, all of which will lead to the creation of more jobs for Australians.

### **National Capability**

**PRIORITY** Substantially increase the number of Australian-based high growth Robotics and AI companies to improve sovereign capability and drive Australia's technology export market.

#### **Actions**

- Fund a robotics venture factory to build infrastructure to accelerate development of robotic solutions, provide improved access to international mentors and support local robotics companies to scale and create global businesses that export.
- Review state/territory and federal government procurement protocols and procedures to further support Australian Robotics and AI startups.
- Incentivise companies to experiment with, and invest in, Australian robotics

<p>technology to grow our capability and domestic market.</p> <ul style="list-style-type: none"> <li>Analyse future supply chain needs and identify areas where Australia must have sovereign capability, helping grow ongoing supply in the future.</li> <li>Grow a pipeline of robotics companies and technologies for potential future investment through the \$15 billion National Reconstruction Fund, with a minimum of \$1 billion earmarked for investment in critical technologies.</li> </ul>
<p><b>PRIORITY</b> Improve the investment and funding environment for Robotics and AI in Australia.</p>
<p><b>Actions</b></p> <ul style="list-style-type: none"> <li>Substantially increase and grow Australian-based high growth robotics companies by addressing funding gaps (increase foreign direct investment) and supporting export development.</li> <li>Apply incentives to encourage both investment in high capital expenditure ventures and adoption of robotics and robotics-related technologies.</li> <li>Encourage collaboration by companies and government agencies to partner, invest and nurture Australian robotics companies as they scale and develop fit-for-purpose solutions.</li> </ul>
<p><b>PRIORITY</b> Increase research and development and improve commercialisation and adoption of locally developed intellectual property in robotics and robotics-related technologies that will lead to an enhanced level of industrialisation.</p>
<p><b>Actions</b></p> <ul style="list-style-type: none"> <li>Explore and analyse competing global research and development programs with the objective of identifying opportune market gaps that can be exploited by Australian technologists.</li> <li>Actively encourage global robotics companies to establish research and development hubs in Australia (instead of only locating sales offices).</li> <li>Establish and fund robotics-related priorities to ensure existing and emerging industries' research and development programs are structured and delivered to support robotics research, commercialisation and adoption.</li> </ul>
<p><b>PRIORITY</b> Reduce barriers to success by promoting cohesion within the robotics ecosystem through the development of supportive domestic and international networks</p>
<p><b>Actions</b></p> <ul style="list-style-type: none"> <li>Support initiatives to drive ecosystem growth, support commercialisation and adoption and enhance domestic and international links with strategic partners.</li> <li>Develop clusters to form the building blocks of a sustainable robotics industry by supporting collaboration, knowledge transfer and entrepreneurial culture.</li> <li>Build better linkages with Australia's strong research base and help bridge the commercialisation and adoption gap to ensure industrialisation outcomes.</li> </ul>

## Existing Strengths

Australia has proven we can deliver high levels of industrial automation in sectors like manufacturing and there are more opportunities to explore as technology advances. We are also a global leader in field robotics, but must overcome some barriers to take full advantage of our capability and experience. The current Australian robotics industry is diverse, existing as either service businesses within major corporations or small-medium sized enterprises

(SMEs) meeting niche market needs. The industry is supported by technological expertise across the university sector and the Commonwealth Scientific and Industrial Research Organisation (CSIRO).

Our key strengths in robotics and automation research, development and production include:

- World-leading field robotics applications developed in response to Australia's unique geography.
- Innovative engineering skills which can integrate and adapt technologies sourced locally/globally with applied knowledge to quickly meet niche market opportunities.
- Talent and technologies developed in niche aspects of service robotics (including soft robotics).
- AI applied to robotics, including computer vision and natural language processing
- Development of control systems (e.g., Ardupilot).
- A strong (but not diverse) pipeline of talent from the school system.
- Progressive regulatory regimes, some of which are exemplars for the rest of the world.

The Australian robotics industry has an opportunity to exploit these strengths by developing Australia as a test bed for new technologies and by further supporting the niche talent and technologies that currently exist. We can build on our pre-existing strengths and early investments in innovation and research excellence in robotics and automation, particularly in fields such as computer vision, machine learning, sensors and sensing technologies and autonomous vehicles. Capitalising on Australia's first mover advantage in many areas will enable services to continue developing a strong robotics economy to benefit Australia in the future. The risk of not doing so may see Australia lose niche capabilities, talent, and technologies to other nations.

**In the future, a range of robotic technologies will be necessary to address labour shortages, deliver our decarbonisation aspirations, as well as help monitor and mitigate the environmental challenges that Australia will face (bushfires, drought and floods).** Many of these are in early stages of development, or aspects of the technology exist in prototype form but are not widely deployed. While the range of environmental challenges that can be tackled is wide, the type of technologies that need to be deployed can be applied to most sectors of the Australian economy, and collaboration on such platform technologies, as well as incentives for Australian entities to adopt them, will be key to their success in the future<sup>7</sup>.

## Related areas

Related areas where Australia could also develop world-class expertise include:

- Quantum sensing and computing (to allow faster data processing on edge devices and better positioning, navigation and timing to support location accuracy).
- Critical minerals (to supply the batteries that will increasingly be used as we deploy more technologies requiring independent power sources).
- Generation and storage of energy (to power remote and off-grid systems effectively).
- Battery technology (to enable increased power supply over longer time periods).
- Recycling (to contribute to a circular economy and ensure the development of hardware does not generate waste).

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<sup>7</sup>A Robotics Roadmap for Australia 2022; Robotics Australia Group, <https://roboausnet.com.au/robotics-roadmap/>

- Nano-technologies (to support development of more efficient materials and components for use in hardware).
- Blockchain (to enable security, traceability, identifiability, privacy and interoperability of data).
- Ethical, legal and regulatory frameworks (to underpin responsible development, diversity awareness and user-centred design of trusted robotic and AI technologies).

## What do we need to do to develop our national robotics capability?

### Investment / Access to Capital

During our consultations, we identified that access to capital is the key issue hindering development. For Australia to develop a thriving ecosystem of robotics and related companies, fundamental changes need to occur in the approach of Australian start-up founders, and investors. Because of their complex nature (hardware, software, human interaction etc), robotics startups need a longer runway of investment before being able to become profitable. Robotics companies (or businesses investing in robotics projects) need better support to help lower risks and costs. Assistance could be in the form of;

- shared ownership schemes (between government or several businesses) to lower upfront infrastructure costs,
- government support/tax incentives for the time/cost to train personnel,
- assistance with risk mitigation (such as insurance support if things go wrong),
- tax offsets or lower interest against robotics purchases/projects, and
- accessible long-term loans for robotics projects.

There is also an opportunity to increase the pool of available capital and increase public awareness and trust of automation and robotics. In recent years, Australians have been able to invest as individuals in startups through crowdfunding schemes such as the Birchall platform<sup>8</sup>. The Government could incentivise investments specifically into robotics and automation startups. This would increase the pool of funds available for robotics, increase public awareness of Australian robotics and incentivise superannuation funds to invest in these projects.

Investment is also restricted by limited adoption of robotics by our local industries, which inhibits companies' ability to scale in the domestic market. Given Australia's strength in field and service robotics, incentives for companies to develop and adopt robotic technology in the construction, defence, resources, agriculture, environment, aerospace, and services sectors will directly impact on the development of sovereign robotics capability. For example, significant gains have been made in mining automation to the benefit of the Australian economy and similarly, scalable technologies are being developed in the AgTech sector. However, Australia currently does not develop industrial robots, therefore incentives that encourage adoption of such robots in sectors such as manufacturing do not have the same uplift potential as other sectors of the economy that rely on locally-produced robots.

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<sup>8</sup> <https://www.birchal.com/>

## Sovereignty and Supply Chain

Australia has unique skills and capability in robotics and a growing ecosystem of companies which rely on those skills. Robotic technologies are vital components of the industrial internet (Fourth Industrial Revolution, 4IR) used in critical infrastructure and defence applications. A lack of skills and capability in these areas poses a credible national security risk. Australia needs to develop and maintain a strong capability in robotics products and services that underpin our critical industries, such as mining, agriculture and defence<sup>9</sup>, in the same way it is recognised that we need a national capability in cybersecurity to protect the ICT industry. For this reason, our defence forces recognise robotics as a 'sovereign industrial capability' priority.

Contrary to expectation, rather than digitisation leading to the democratisation of technology across the world, it has instead led to the agglomeration of innovation. Over the past decade, we have witnessed the migration of skills, companies and capital to innovation clusters such as Silicon Valley<sup>10</sup>. Since COVID-19, governments world-wide have recognised that value-creating activities such as building robots, developing related technologies and seeing these adopted in the domestic market are sovereign capabilities that need to be nurtured and protected. We should also recognise the value that could be created by building export-focused manufacturers (e.g., aerospace/space and disaster tech<sup>11</sup>) in areas where Australia has competitive advantage (i.e., knowledge workers to exploit the higher value-added segments on the Smiling curve)<sup>12</sup>.

Australia's robotics industry requires reliable access to resilient and trusted domestic and international supply chains for key materials and components. These complex global supply chains are vulnerable to disruption, resulting in unpredictable availability and costs. The National Robotics Strategy can analyse future supply chain needs and identify areas where Australia must have sovereign capability, helping grow ongoing supply in the future.

## Commercialisation and Adoption

### The pathway to commercialisation and adoption in Australia

Australia's poor performance translating research into commercial products is a well-known and complex problem - often referred to as the innovation imperative<sup>13</sup>. It combines a lack of ambition, a failure to collaborate, limited access to venture capital, poor economic complexity and, most noteworthy, the absence of representation from industry who would be required to produce the technology or who would provide the conduit for adoption<sup>14</sup>. While some of these weaknesses have been addressed in recent times with the creation of Robotics Australia Group, one of the most significant challenges remaining is the ability of

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<sup>9</sup>Australian Sovereign Defence Industrial Capabilities: Robotics, Autonomous Systems, and Artificial Intelligence.  
<https://www.minister.defence.gov.au/minister/melissa-price/media-releases/morrison-government-supporting-australia-sovereign-defence>

<sup>10</sup> Growing the digital economy in Australia and New Zealand Maximising opportunities for SMEs  
<https://www.pc.gov.au/research/completed/growing-digital-economy/growing-digital-economy.pdf>

<sup>11</sup>Data61 A New Chapter: Opportunities to seed new industries for Queensland over the coming decade  
<https://data61.csiro.au/en/Our-Research/Our-Work/A-New-Chapter>

<sup>12</sup>AMGC Sector Competitiveness Plan 2020: Taking Australian Ingenuity to the World  
<https://www.amgc.org.au/wp-content/uploads/2021/04/AMGC-Sector-Competitiveness-Plan-2020.pdf>

<sup>13</sup>Australia's Innovation Future: A Report on the Structure and Performance of Australia's National Innovation System  
<https://www.howardpartners.com.au/assets/report-on-the-structure-and-performance-of-australia-s-national-innovation-system.pdf>

<sup>14</sup>Australian Centre for Computer Vision: A Robotics Roadmap for Australia 2018  
[https://apo.org.au/sites/default/files/resource-files/2018-06/apo-nid176691\\_1.pdf](https://apo.org.au/sites/default/files/resource-files/2018-06/apo-nid176691_1.pdf)

our SMEs to scale and access global supply chains. There are many examples, where SMEs have been forced to move overseas in order to grow or have been acquired by multinationals – Robotics Australia Group is keen to partner with governments to discourage this trend and retain the growth in Australia.

Our consultation process identified the path to commercialisation as a key weakness in transitioning robotics from the research and development (R&D) stage to a market-ready product in Australia. While some innovations in Australian robotics have market potential, they often require significant capital to commercialise and generally take longer than software or consumer-based technologies to achieve a return on investment. Often, the Australian market is not large enough to justify the development of high capital expenditure (capex) technologies. Policy initiatives, such as tax incentives and asset write-offs, can help facilitate the transition of high capex technologies to markets in and outside of Australia. Investment (of time and resources) should be focused on areas that show high potential to expand within the local market.

To maximise the potential of research commercialisation, it is important for universities and companies to work collaboratively. Universities can provide the necessary research and intellectual property, while companies can take these findings and translate them into commercial products that benefit both parties. Companies are better positioned to develop and produce robotics and automation technologies as they have a deep understanding of market demands, manufacturing processes, and distribution channels. Companies can be motivated to invest in robotics and automation R&D to achieve a competitive advantage by being early adopters of new technologies. While research organisations may be vital to the development of new technologies, they may not be best suited to bringing these technologies to market and should be encouraged to release their IP for development.

### Shared Infrastructure in Robotics

Australia will benefit from investing in infrastructure necessary to support AI-enabled robotics and automations companies, such as data centres, cloud computing, high-speed networks, rapid prototyping, high-fidelity experimental testbeds and environmental sensing infrastructure to support the development and deployment of new technologies. Australia is a perfect test bed for new robotic technologies, as has been evidenced by the testing of drone technologies in Australia by tech giants such as Google<sup>15</sup>. Australia has a large land mass with scattered settlements (low population density), a wealthy population of early adopters of technology, and regulators that generally work in well with industry.

The creation and maintenance of large-scale robotic test beds, or experimental facilities, are key to supporting the progression of robotic technologies through critical stages of hardware development, Technology Readiness Level (TRL) 5 through to 9 (commercial ready). To date, Australia does not have these facilities. Test beds can act as ways to take R&D from theory to prototype and then to a minimum viable product that can be tested in the market. While testbeds are resource-intensive, this makes them well-suited to a shared and even remote-access format. To be successful, such test beds need to cater to a variety of robot systems that can be used to test the utility of algorithms and to supply modular interoperable hardware (plug-n-play) for remote testing against physical and virtual

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<sup>15</sup> <https://www.canberratimes.com.au/story/8115878/more-flying-coffees-forecast-as-google-tests-drone-tech/>

benchmarks. They also require validation, which exposes the need for frameworks (standard test methods and metrics) to assess the quantitative performance of different robotic technologies. The creation of a common testbed was a feature of Robotic Australia Group's Robotics Venture Factory concept (see below).

## The Importance of Clustering

Global evidence has demonstrated that high-technology industries, such as robotics, perform more strongly when heavily concentrated in regional 'clusters' in close proximity to universities that have leading expertise in the field. Silicon Valley could not exist without Stanford University, and the Silicon Valley Robotics cluster consists of more than 500 companies<sup>16</sup>. Pittsburgh Robotics Cluster recently received USD\$62m to enhance the cluster of more than 100 companies it forms around Carnegie Mellon University (CMU)<sup>17 18</sup>, and a robotics factory to help create, accelerate and scale the development of robotics start-ups. The Boston robotics cluster, MassRobotics<sup>19</sup>, would not exist without close proximity to the robotics research being done by MIT and Harvard, which has attracted the location of Amazon Robotics to the region<sup>20</sup>. Proximity and relationships to entrepreneurs, industry experts, financial and accounting specialists, marketers, and related businesses also determine the success and intensity of a high-technology cluster<sup>21</sup>.

Clusters facilitate an environment that encourages the adoption we need for our fledgling emerging technology companies to grow and for the intertwined investment of talent and resources to solidify. They tend to be more productive and attract both investors and a highly skilled workforce, creating a hothouse for generating new ideas, new applications, and the establishment of new companies to exploit these. Australia already has notable hotspots that have attracted talent and funding for fundamental research, higher level research training, field robotics, and specific technology development (e.g., mining automation technologies). For Australia to be internationally competitive in the areas of robotics where it excels, we must support SMEs to advance their technologies up the Commercial Readiness Level (CRL) scale. For this to happen, existing hotspots must continue to be used to grow local ecosystems of innovation, with ready access to mentoring, finance, business and marketing advice, as well as providing an opportunity to build connections across the value chain. A national approach to developing new clusters to avoid duplication and competition must also be explored.

## The Robotics Venture Factory

One key potential solution to address some of these challenges, developed by Robotics Australia Group, is the development of a robotics venture factory. The 'factory' concept aims to build infrastructure that accelerates the creation of Australian made robotic solutions for a variety of sectors. It fills a gap that exists currently for robotics companies to navigate the final steps of solution development (TRL7 and TRL8) and scaling manufacturing into operations (TRL9).

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<sup>16</sup> <https://svrobo.org/about-us/>

<sup>17</sup> <https://nextpittsburgh.com/latest-news/pittsburgh-region-granted-62-7-million-to-grow-the-robotics-industry/>

<sup>18</sup> <https://robopgh.org/cluster-profile/>

<sup>19</sup> <https://www.roboticsfactory.org/>

<sup>20</sup> <https://www.massrobotics.org/>

<sup>21</sup> O'Mara, M 2005, *Cities of Knowledge: Cold War Science and the Search for the Next Silicon Valley*, Princeton University Press

The 'factory' provides the necessary connective tissue between innovators, inventors, creators and researchers to investors, manufacturers, parts/component suppliers (both national and aggregated international supply chains), fabrication facilities, and existing test and development environments. It supports local robotics companies to advance the commercial readiness of their technologies, enabling them to scale and create global businesses that access international markets, by providing resources to strengthen service delivery as well as support and advisory services. The factory concept draws on knowledge from similar initiatives in both Europe and the US, but with a focus on field robotics, where we have a global leadership position. Implementation of the concept will increase our sovereign capability in the development and commercialisation of robotic technologies, increase jobs (particularly in regional areas), provide meaningful career pathways for mechatronics graduates and also increase exports.

### Advancing Technology through National Challenges

Challenges can increase the effectiveness of technology development and diffusion by fast-tracking delivery of aspirational goals that are currently technically impossible to achieve. We propose that the creation of a series of Australian challenges, to be solved by the robotics and broader communities, will fast track development of technologies. The challenges will need to focus on pressing national issues, stimulate collaboration and spark the public's imagination of the possibilities these new technologies present. Challenges will also help to test robotics technologies in different settings within Australia and help to establish regulation ahead of market penetration of new technologies.

### Trust, Inclusion and Responsible Development and Use

**PRIORITY** Ensure ethical robotics solutions meet public expectations, improve Australia's well-being and are consistent with our democratic values.

#### Actions

- Leverage work around responsible AI to develop suitable ethical, legislative, and regulatory frameworks for the production and adoption of robotics technologies.
- Develop appropriate national operating, interoperability, risk management and safety standards for robots, aligned to international standards.
- Create a government body to expedite the approval of new technology applications for commercial use. The body would collaborate with other government agencies, industry and unions to expedite the path to commercialisation for Australian developed technologies.
- Improve community awareness on the opportunities and limitations of robotics technologies, including job creation, improved service delivery in remote areas, efficiency and productivity gains, and safety.

**PRIORITY** Develop and adopt governance systems to ensure Robotics and AI solutions improve Australia's wellbeing and protect democratic values.

#### Actions

- Work across government to ensure that regulatory measures and frameworks are fit for purpose to maximise opportunities for robotics and AI and manage risks while protecting Australia's national interests.

- Develop and/or adopt appropriate standards to ensure the safe deployment of robotic technologies which meet appropriate ethical, legal and regulatory frameworks.
- Develop policies that preserve social cohesion by protecting individuals from bearing the brunt of disruptive change and ensuring societal benefits.
- Fund interdisciplinary research to address social and cultural issues and concerns relating to the development of robotics to establish a social licence for robotics.
- Fund an awareness campaign across industry, government and the wider community on the benefits of adopting robotics and robotic-related technologies (such as improved service delivery in remote areas, productivity gains, safety, job creation and supply chain security).
- Explore options to strengthen collaboration and opportunity for industry with our established partners through existing arrangements and potential partnership arrangements, including AUKUS, the Quad, and other regional and special bilateral agreements.
- Identify and consider opportunities to grow Australia's regional leadership through collaborative programs of research, science diplomacy and provisioning access to infrastructure.

As robots increasingly interact with people in their daily lives, consideration must be given to how humans design, construct, use and treat robots, and other AI. To ensure ongoing social cohesion in the face of technological disruption, it is important that no Australian is left behind. We hear from the robotics ecosystem that navigating standards and regulations and determining what constitutes responsible development and use are barriers to the development of a robotics industry in Australia. The National Robotics Strategy can play an important role supporting homegrown robotics and automation companies, to ensure that their technologies are worthy of trust and expedite the pathway to market.

## Responsible Development and Use

A movement towards ethical design of technology has seen researchers and companies deploying frameworks for new technologies. Robotics can leverage Australia's AI ethics framework<sup>22</sup> and also the principles of responsible AI being discussed as part of the National AI Centre<sup>23</sup> to develop our own set of roboethics and design principles to protect people from robots and vice versa, taking care to:

- Protect humans from harm
- Respect the refusal of care given by a robot.
- Protect humanity against privacy breaches committed by a robot and against the risk of manipulation by robots.
- Manage personal data processed by robots.
- Avoid the dissolution of social ties.
- Equal access to progress in robotics.
- Restrict human access to enhancement technologies.
- Protect robots from systematic abuse.

Like the EU, Australia could mandate that robot design incorporate the following considerations across all robot types: safety, security, traceability, identifiability and privacy.

<sup>22</sup> <https://www.industry.gov.au/publications/australias-artificial-intelligence-ethics-framework>

<sup>23</sup> <https://www.csiro.au/en/work-with-us/industries/technology/national-ai-centre/responsible-ai-network>

The role of designers, policymakers and society should be to decide whether a system should be built at all, before being unleashed on important public infrastructure such as hospitals or courtrooms. Factors that contribute to intuitive use of products<sup>24</sup> need to be determined for robotics. Social uptake of robotics and automation will be strongly dependent on how people experience the use of the technology. The development of intuitive user interfaces can make these technologies accessible to more people, allowing them to have a greater positive impact on the world<sup>25</sup>. Developers of new robotic technologies should apply the principles of value sensitive design, which typically relies on focus groups or other techniques, to establish stakeholder views on a range of issues such as data privacy and cultural sensitivities that can then be incorporated into technology design.

## Safety, Standards and Regulations

Robots should be safer than humans at achieving the same tasks, because they are engineered systems not burdened by human fallibility (except in their conception). Traditionally, robots have operated in interlocked cells, isolated from people to ensure human safety. However, modern robotic systems allow more collaborative applications and many robots must operate in public spaces, such as the Little Ripper lifesaver drones or retail robots. For this reason, ensuring that robots can operate safely in public, unconstrained environments is becoming critically important.

There are a number of well-developed ISO and IEC standards for safety related control systems for machines and machine specific standards including robots, AGVs and other vehicles. For the industrial robot sector (ISO 10218 series) international standards have already been adopted as Australian Standards under the primary machine safety standard series AS4024. The safety control system standards base the control system design on risk variables and lead to architecture changes in the control system as the risk increases. At the higher levels of risk this requires redundant controls with fault detection. This approach for machine safety control systems has been in place for around 30 years. International standards are also in place for service and personal care robots. Similar standards are in place and evolving for autonomous and self-driving vehicles. Current safety standards in certain industries are evolving but need investment to extend their application to new environments, use across industries, and for more than one purpose.

Technology is regulated differently depending on the sector. The challenge for the Australian robotics industry is to identify, adopt and promote trust and safety frameworks that align to a manageable assurance framework, are accepted by Australian society, and are pragmatic for robotics industries to incorporate and abide by. Frameworks to systematically and efficiently accredit robotics and AI technology do not exist, while current standards and assurance mechanisms are not fit-for-purpose as they generally require either human operators to be in constant control, or for robots to be kept physically separated from human operators (e.g. industrial robots). Approval for new robotics technology requires in-depth regulatory engagement, meaning it can take much longer than usual for a manufacturer or operator to get approvals from the relevant authorities. As existing laws and regulations rely on a human operator being responsible, this means most robotic platforms must seek exemptions to

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<sup>24</sup> Blackler, A. Popovic, V. & Mahar, D (2003) Designing for Intuitive Use of Products: An Investigation, Asian Design International Conference.

<sup>25</sup> Robotics Roadmap for Australia 2018. Robotics Australia Group.

operate, which are difficult to get without investing significant time into the regulatory engagement process. We recommend moving to a more modern risk based, responsive, and anticipatory regulatory approach, proactively taking opportunities to support positive innovation.

Interoperability is a challenge facing the adoption of automation and robotics, and is a mixture of technological, commercial and regulatory challenges. The Institute of Electrical and Electronics Engineers' (IEEE) Robotics and Automation Society Standing Committee on Standards Activities is experimenting with standards that allow robots to interact and communicate with other robots, but these standards are not enforceable, a matter that should be urgently addressed.

## A Fair Society

Consultations during the development of this submission and its recommendations repeatedly reinforced the need to be mindful of the disruptive potential of robotics technologies and the community's perception of robotics. As Australia enters the age of the Fourth Industrial Revolution (4IR), lessons need to be learnt from the past. After the first industrial revolution, economic conditions for the working people fell for several decades until economic and social measures were put in place to create a fairer system. Those measures and the fairness they support are an important part of the Australian labour market which has continued to reform with the times. Over the last 40 years, there has been a rise in part-time and casual work, and some workforce restructuring has been due to technology and a greater take-up of automation and robots. Despite this, the measure of income equality used by the OECD and the Australian Bureau of Statistics, the Gini CoEfficient, has remained largely stable this century.

Future advancements in the application of robotics and automation will continue to give rise to further concern about inequality. While many people will benefit from robotic technologies, the risk to social cohesion if those benefits are not evenly shared justifies an urgent focus of social policymakers. Good policy planning is required to protect individuals from bearing the brunt of change which will deliver broader societal benefits.

## Skills and Diversity

**PRIORITY** Significantly increase Australia's technology workforce and expand community literacy in Robotics and AI.

### Actions

- Grow the Robotics and AI talent base by increasing university and TAFE graduates, diversifying pathways into robotics, supporting work placements and expanding community literacy of robotics through dedicated funding and policy support.
- Collaborate with organisations in the education sector to address workforce challenges (skills, talent, attraction, retention and diversity).
- Sponsor programs to support indigenous workforce participation.
- Provide funding and resources to review and update national curriculums across all education levels to provide greater focus on digital and technology skills.
- Actively promote Australia as a robotics destination to attract talent and introduce strategies to attract and retain skilled migration specialising in Robotics and AI.

- Develop a national training and incentives program to encourage workforce transition to more technical roles by leveraging tools such as micro-credentials.
- Subsidise robotics companies to provide internships that give graduates on-the-job experience without jeopardising company success, consider a program to rotate interns to different SMEs to provide broad experience.
- Launch a national competition to develop leading robotic solutions for key challenges to spur industry growth.
- Develop a national online library of industry-recognised and universally accepted micro-credentials.
- Provide robotics technology talent PhD scholarships with subsidies for international students (to address domestic workforce supply issue).
- Release a robotics workforce report modelling future educational and workforce needs, including skills taxonomies.
- Fund a public awareness campaign to expand community literacy in robotics and AI and understanding of the risks and benefits.

### Australia's Robotics and Automation Workforce

In the future some jobs will change, and new jobs will be created, with the most impacted sectors of the economy expected to be manufacturing and services. To harness the benefits of automation, jobs must be created in other parts of the economy. An example of this shift in jobs can be seen in the computerisation of the finance sector, which has shifted work away from administrative service positions to more technologically complex areas supporting the computerisation.

In addition to automation, robotic technologies also have the potential to make existing jobs safer, more satisfying and more creative, while at the same time reducing the dirty, dull and dangerous aspects of many occupations. Appropriate planning and development of alternate career paths for displaced workers can minimise the impact on workers, resulting in more productive industries and newly re-skilled workers deployed elsewhere. In some key sectors where there are chronic labour shortages, automation is essential.

Meeting our current and future skills needs in robotics requires a pipeline of talent from schools, through universities and vocational training and into industry. We need to develop and promote robotics career paths as a way to solve real-world problems that the community is invested in solving. Australia's world-class education system, with a focus on robotics in curricula, along with a good R&D base in robotic technologies, means that there is a high-quality pool of talent available to reposition

Australia is a knowledge-driven robotics nation with our technical expertise well-regarded internationally, making our graduates highly valued targets for recruitment by global technology giants and overseas research institutions. Consequently, many Australian graduates and researchers with relevant capabilities leave to work overseas due to lack of local employment opportunities. Ideally, the aim is to see Australian graduates find opportunities in Australia, either joining established companies or by starting their own enterprises. The key challenge for the fledgling robotics industry is to build a path from research to commercialisation of products and services that will support the achievement of this aim.

There is significant opportunity to add to the robotics industry workforce through diversity by creating an attractive environment for women and minorities to join the field and also assisting mature age workers to reskill to join the industry. Robotics Australia Group has contributed to the *Women in Robotics* submission on this topic and endorses the recommendations put forward. As well as creating homegrown talent to support an Australian robotics industry, there also needs to be consideration of how to become a net importer of suitable talent by making Australia a recognised “robotics destination”.

## Skills required for a Robot Economy

How do we educate our children for the jobs of the future? How can we help the current workforce adapt? What are the skills needed for a new robot economy?

According to the World Economic Forum, skills to focus on are: complex problem solving, creativity, people management, critical thinking, coordinating with others, emotional intelligence, judgement and decision making, service orientation, negotiation, and cognitive flexibility. Equipping the Australian population with fourth industrial revolution skills is increasingly a national priority. Frameworks to develop inclusive workforce-critical digital capabilities, technical skill sets, social and emotional skills, as well as adaptability and resilience require national leadership. Thus, strengthening our economy to withstand future disruptions requires government, education, and industry stakeholders to collaborate on workforce skills training and support.

Long term goals for the Fourth Industrial Revolution (4IR) vocational education include:

1. Delivery of free, open access micro-credentials on entry level 4IR topics, such as digital literacy.
2. Development of micro-credential courses for the workplace based on industry need, emphasising common 4IR technician, maintenance or paraprofessional level tech management skills, e.g., cobot programming, using an internet of things dashboard.
3. Curation of a national online library of industry-recognised micro-credentials.
4. AISC revision of the IRC structures to better integrate SME employers into a VET development consortium.
5. A campaign for stronger inclusion of soft skills in curricula.

## Increasing Adoption

**PRIORITY** Accelerate and amplify the development and adoption of Australian made Robotics and AI solutions.

### Actions

- Introduce tax and other incentives, such as asset write-offs and access to capital financing, for companies who adopt and deploy locally developed Robotics and AI, as part of the ‘Made in Australia’ campaign.
- Prioritise assistance for SMEs to adopt new technologies, including access to low cost, high fidelity simulation to reduce risk and streamline integration.
- Refocus Australia’s digital transformation to target the development and adoption of Australian developed robotics and robotics-related technologies, particularly for greenfield sites where it is easier to implement new technologies than in

brownfield sites.

- Establish a national government body to expedite the approval and adoption of new technology applications for commercial use across key industries (such as healthcare). The body would be further tasked with collaborating with other state and national government agencies, industry and unions to expedite and incentivise the path toward commercialisation and adoption of Australian technologies.
- Introduce a Robotics and AI-first use strategy for Australian and state/territory governments and change government procurement practices to preferentially support Australia robotics and include specific KPIs in government contracts that involve engaging with robotics providers to trial their products and services.
- Support the creation of robotics clusters and 'living labs'/technology precincts to showcase Australian solutions and enable testing and development with Australian industry and government.

Australian businesses are limited in their adoption of robotics, which means there is great potential to benefit from adoption in different ways suited to the characteristics of their sector.

Manufacturing is the earliest adopter of robotics as manufacturing tasks are often repetitive actions, such as assembling components, which can be easily automated and are done within the confines of a controlled environment in the form of a factory. Industrial robots can perform these tasks with high precision and consistency, resulting in improved quality and productivity. Australian manufacturers use robots for assembly, welding, painting, and quality control. Australia does not currently build industrial robots so these robots are sourced overseas, however some Australian businesses have developed their own in-house robotics systems and there are several Australian businesses focussed on integration of robotic systems. Interventions that support Australia's manufacturing sector to adopt robotics have not yet directly supported the Australian robotics industry but can help bridge the "integration gap", where there appears to be a market failure. Other sectors can benefit from the lessons learned in Manufacturing to more quickly and effectively introduce robotics into their operations.

Logistics and warehousing are adopting mobile service robots (AGVs - automated guided vehicles) that are used for tasks such as inventory management, order picking, and packaging. These service robots are flexible and mobile compared to industrial robots but benefit from operating in a relatively predictable factory setting. Such robots are increasingly being used in other sectors such as healthcare in hospitals and aged care facilities to transport food, linen and equipment and perform other back-of-house functions. In the Retail sector, mobile service robots are being used in front-of-house functions, such as serving food and drinks. These types of service robots are mainly imported from overseas. More complicated surgical robots are used in many private hospitals and are sourced from overseas but a young Australian start-up, Convergence Medical, is emerging in this space. Interventions to support the adoption of service robots used in healthcare and logistics are unlikely to directly support the Australian robotics industry unless tests for inclusion of Australian developed products and services are applied.

Agriculture, mining, construction, infrastructure and defence are early adopters of field robots, including UAVs (drones) for tasks such as crop monitoring, yield estimation, and

irrigation management. Australian company SwarmFarm Robotics has developed robots that can perform tasks such as weed control, while a number of Australian mobile robot companies supply bespoke solutions to the mining and defence industries. Interventions in sectors that adopt field robotics tend to directly support the Australian robotics industry if care to support 'Made in Australia' initiatives is taken. As an additional benefit, many of these will have strong environmental benefits as Australia strives to meet its decarbonisation targets.

It is important to note that robotics and automation will transform all sectors of the economy as shown by the many case studies included in the 2022 Robotics Roadmap for Australia<sup>26</sup>. Some obviously significant sectors should be immediately targeted, for instance, Construction, a low productivity, high risk sector facing a labour shortage where field robotics can have a real impact. There is also a great opportunity to apply the learnings from Manufacturing and the adoption of industrial robots over the last 70 years to the adoption of emerging field and service robots, particularly as the Advanced Manufacturing sector evolves and increasingly looks to cobots and more mobile robots to extend automation on the factory floor. In the future it will be valuable to see Australian integrators that can support the adoption of the full range of robots from industrial through to field robots.

### Barriers to Adoption

Australia is a nation of SMEs and one of the key barriers to adoption of new technologies is the large number of companies with low innovation capacity. Meaningful programs that stimulate the private sector to fill this gap (rather than creating competition with the private sector) can play an important role in helping to build and sustain the robotics ecosystem and help fill the integration gap - which sees Australia lacking companies providing services to assist companies adopt robotics technologies (integrators). Giving SMEs access to low cost, high fidelity simulation software to reduce risk by allowing virtual prototyping, design and commissioning of new technologies will also aid adoption and encourage investment.

Other significant barriers to adoption of robotics include (1) the high cost to purchase and maintain the technology (2) the shortage of integrators with specialised knowledge and expertise to help implement the technology and (3) unrealistic expectation from industry that new technology will be "perfect" and that no experimentation is required. A lack of skills and training in the businesses, as well as resistance to change, can also act as barriers. Unrealistic expectations of the technology and unwillingness to adapt existing systems and processes to leverage robotics strengths can also limit the application of robotics. Finally, the main barrier to adoption of Australian robots is access to capital, with Australian robotics start-ups needing additional funding and support from customers to bring their products to market, which places a high level of risk on the customer compared to products from more well-funded overseas competitors.

### Overcoming Adoption Challenges

To address these challenges requires investment in both the companies adopting robotics and the Australian companies creating the robots, to incentivise risk taking and preferentially support Australian-made products. Pooling resources and expertise by encouraging collaboration between government, universities, businesses and robotics companies can

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<sup>26</sup> Robotics Roadmap for Australia 2022; Robotics Australia Group, <https://roboausnet.com.au/robotics-roadmap/>

reduce the barriers of cost and complexity. While investment in education and upskilling of the general population and workforce planning is also important and can help to overcome resistance to change. Finally, ensuring government procurement prioritises locally-produced products and services, and supports an increased risk appetite to encourage adoption of immature solutions, will strengthen the Australian robotics industry.

The current speed of technology development is faster than regulators can respond, so the adoption of an anticipatory regulatory framework is recommended, which allows for innovation and experimentation. Our network identified the difficulty of obtaining affordable insurance, both for companies producing and adopting robots. Robot insurance needs to be normalised like insuring your mobile phone or other portable electronics.

## Conclusion

Robotics will advance economic productivity and quality of life when used appropriately. Australia needs to act now to be part of this inevitable change. The convergence of robotics technology with artificial intelligence, and the application of the data collected through the exponential growth of sensors will see a range of possible futures for Australia emerge. The National Robotics Strategy is our opportunity to build the foundations that will allow robots in Australia to unlock human potential, diversify and modernise our economy, develop long-term environmental sustainability, and deliver equitable health and well-being outcomes for all Australians.

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## About Robotics Australia Group

*Robotics Australia Group is Australia's peak body for the Australian robotics (and robotics-related) technology sector with a network of more than 5,000 and an international alliance with similar organisations in other countries. Our goal is to build a sustainable robotics industry by supporting the entire robotics ecosystem, from the companies building robots to those researching and developing new robotic technologies, robotics educators and enthusiasts, and the companies looking to adopt robots and robotics-related technologies. Our members and partners include large and small companies that create or adopt robotics technologies.*