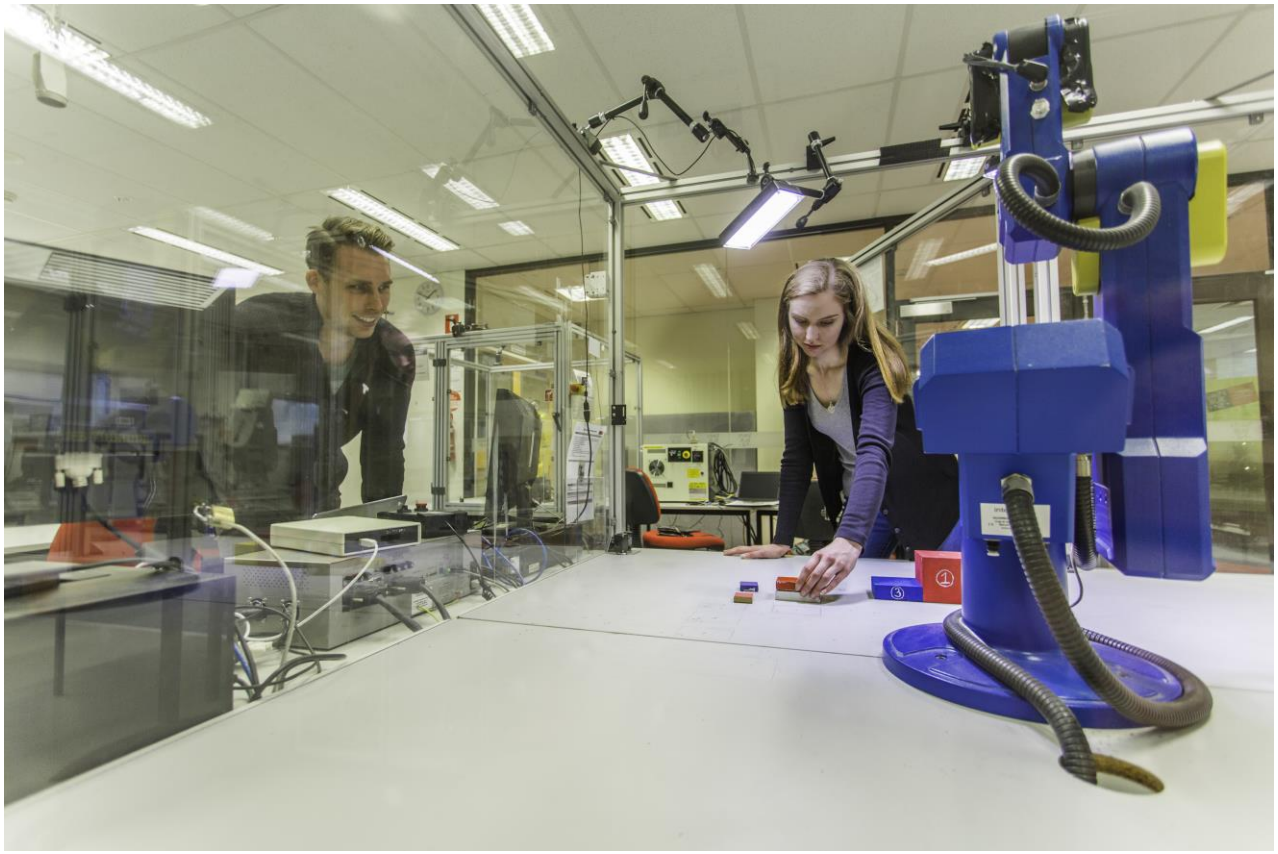
Swinburne University of Technology



National Robotics Strategy Discussion Paper Submission

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Introduction

Swinburne University of Technology welcomes the opportunity to contribute to the consultation process on the National Robotics Strategy.

The COVID-19 pandemic has resulted in a seismic global shift, nations are prioritising now more than ever in domestic production capabilities. Supporting investment in robotics and enabling technologies is key to strengthening local supply chains and ensuring countries remain competitive in global markets.

Recent examples of this shift to domestic production are in the USA through the Inflation Reduction Act with $500 billion in new spending and tax breaks encouraging manufacturers in critical supplies to establish facilities domestically. In Australia the recently established $15 billion National Reconstruction Fund will support companies and foreign investment to boost production locally through seven priority areas all heavily reliant on robotics and automation technologies.

Swinburne recognises the vast opportunities to the Australian economy through supercharging investment into local robotics and automation capabilities, however this will not occur without government assistance to address challenges that we are yet to formulate a response to, this includes:

- Concerns in the community about potential impact to jobs in certain sectors
- Slow to adapt education offerings to ensure adequate skills in robotics
- Existing domestic workforce shortages across numerous sectors
- Lack of incentives and support to local manufactures to invest in robotic capabilities
- Limited adoption of robotics across all sectors of the economy

Australia, and especially Victoria, has a long-celebrated history in manufacturing. How we build things has changed in leaps and bounds over the last decade alone due to the adaption of robotics. Swinburne houses the Factory of the Future that has supported more than 500 SMEs to transition to advanced manufacturing, partners with the CSIRO in our National Industry 4.0 Testlab and conducts complex projects with Industry worldwide through our Centre for Advanced Manufacturing. Through each of these vehicles, we have commercialised and found market gaps in several domains, including for example aerospace engineering, hydrogen exploration and use, as well as the adoption of 3D printing for equipment for an aging population and people living with a disability.

Swinburne's reputation for being an industry-friendly university continues to be reinforced today, with a strong focus on research commercialisation such as collaborating with Breakthrough Victoria and ColdQuanta to establish a quantum technology centre, the industry transformation work delivered through the AIRHub and the Victorian Hydrogen Hub, to continuing our 20+ years of investing in technology spinouts through Swinburne Ventures.

At Swinburne, we understand the importance of translating academic research into commercial enterprises. Our academics work to turn their research into practical solutions for society in areas such as health, sustainability, and space and aerospace. We have a strong tradition of connecting academia with industry to build the businesses of the future.

In response to the consultation paper, we have selectively chosen which questions from the consultation paper to respond to, set out below.

Promoting skills and opportunities in robotics in early school years.

This section addresses questions 12, 13, 15, 17, 18

Swinburne agrees with the discussion paper, we need to build on the pool of smart, innovative Australians excited about robotics to support a thriving robotics sector, this participation needs to occur earlier not just in secondary schooling but also primary and early childhood learning, even 3-year-olds can be emersed in interactive robotics play in a safe supervised environment.

Swinburne is a leader in early learning of robotics developing the Early Learning with Robotics Play Program. An Australian first, it is an evidence-based program emerging from an international study (2018-current) involving Australia, Norway and England early childhood and home-based settings.

The aim of this program is to provide evidence-based resources and equipment for educators and communities to better understand strategies and techniques for improving children's social-emotional, communication, literacy and oral language skills as well as early numeracy skills through robot play. Only when children learn and practise these dispositions in their real-world natural learning environments in their early years, they are better prepared to engage with STEM trajectories in their future schooling years.

The research has signalled that by playing with robotics technologies, a child's natural curiosity and sense of inquiry-based dispositions and social communication can be harnessed. Robotics offer multimodal ways of engaging and meaning making – through touch, sound-visual-movement, codable functions, storytelling and physical encounters– that go beyond simple screen time or printed text.

Since 2021, the Robot Play Program has successfully rolled out to eight kindergartens across Victoria thanks to funding through the Victorian Governments School Readiness Program. Feedback to date has been extremely positive from kids, parents and educators.

In primary and secondary schools, we need to lay the foundations for our next generations to gain valuable skills and knowledge in robotics before they walk out of the classroom, working with industry partners they need to explore career options in robotics. This can be done through exposing them to a range of learning experiences with industry tailored engagement activities. In order to support this engagement, government would need to support industry in these engagement activities with schools.

Through robotics education in schools, you can prepare students for the principles, design, construction, and programming of robots with skills including problem solving, creativity and innovation, collaboration and teamwork.

The Swinburne robotics team already achieves these goals through real world applications and industry engagement, including industry-based projects, visits, speakers and work experience, to equip school students with practical skills to apply theoretical knowledge to real-world scenarios. Students work together in teams to design, build, and program robots, as well as enhancing effective communication skills, cooperation, and the ability to work towards a common goal.

Through early learning and industry led programs, there is an opportunity to foster a whole generation of workers into robotics related jobs, in addition through early intervention trust and approval of robotics would be embedded at a young age further breaking down barriers that currently exist.

Swinburne makes the following recommendations to support greater interest in robotics at a younger age:

- Working with universities, provide funding to expand nationally the early learning programs using robotics.
- Develop and fund an industry lead engagement program with both primary and secondary schools in collaboration with universities.

Address skills requirements for robotics jobs now and into the future

This section addresses question 5, 8, 10, 11, 12, 13, 15, 16, 17, 18, 19

The study of robotics combines mechanical engineering, electrical engineering and computer science and as such requires broad theoretical training in these fields. However, effective robotics practice also demands a hands-on background, ideally with strong industry links. Hands-on experience allows roboticists to truly grasp both the complexities and the subtleties of their craft and harness the full potential of their equipment. Industrial real-world applications provide invaluable context to their studies and afford critical skills for when they enter in the workforce and thus placing Australia at a competitive advantage on the world stage.

As a dual-sector and industry-engaged university, Swinburne provides both theoretical, and hands-on skills training in robotics and automation from vocational education right through to higher education, and upskill to industry. Swinburne houses the Factory of the Future that has supported more than 500 SMEs to transition to advanced manufacturing, partners with the CSIRO in our National Industry 4.0 Testlab and conducts complex projects with Industry worldwide through our Centre for Advanced Manufacturing.

Project-based learning (PBL) is a recommended approach that we believe provides students with the best possible education experience in robotics education. PBL emphasizes a top-down learning method in which students are presented with a complex system and then encouraged to explore its components. Projects selected for PBL should be derived from a real industry set up and endorsed by industry professionals. Lack of motivation is a common challenge for today's students. PBL and top-down learning methods can help students develop the skills necessary to become lifelong learners. They are also more likely to engage in self-study and develop critical thinking, communication, and collaboration skills.

Hands-on training is essential for students to benefit fully from robotics education. Classroom setup in vocational training for robotics is a combined learning environment of theoretical knowledge and practical application. This classroom setup combines traditional lecture rooms and labs where students can learn the theory and then apply it directly to experiments and practice using a range of equipment and tools. Swinburne University of Technology, for example, offers students access to the latest robotics equipment

and low-cost Lego kits for basic units, providing each student with the opportunity for hands-on experience.

The combination of advanced robotics and other technologies, such as artificial intelligence in Industry 4.0, has created many opportunities to change how businesses operate. When combined with entrepreneurship skills, students are motivated to create new opportunities for the Australian industry. We recommended teaching entrepreneurship skills and exposing students to industry innovation opportunities.

It is also crucial to focus on the impact of robotics education on traditionally underrepresented groups such as female participants and Indigenous students. There is a low intake of students from these backgrounds in robotics courses – however given the increasing reach of robotics across the population it is crucial we have a broad participation from the whole community to ensure not only we harness the best and brightest minds, but we have representation from varied backgrounds as the field develops.

Establishing strong relationships with industries is key to the success of robotics education and research programs. By collaborating with industries, educators can create meaningful projects that align with the needs and demands of the real-world workforce. Such collaborations can bring the latest technologies, knowledge, and expertise to the classroom, creating opportunities for students to gain hands-on experience with cutting-edge tools and techniques. Furthermore, building industry relationships can help create education programs that significantly impact the wider community. Swinburne's Red Cross project is one example of how industry and education can work together to create impactful robotics projects. In this project, vocational education and research teams collaborated with the Australian Red Cross, bringing together students, educators, and industry professionals. Such collaborations not only benefit the students but also have the potential to contribute to the wider community and address pressing real-world problems.

To facilitate the development of skills required in robotics across the broad range of industries universities must be equipped with the right equipment, the right staff and the right students.

Swinburne makes the following recommendations to strengthen skills and training in Australia:

- Hands-on, industry engaged training, harnessing both vocational training and higher education settings and incorporating entrepreneurship and innovation skills, Jobs and Skills Australia can be tasked to undertake a broad analysis of robotics related education in both sectors and suggest best options for the future.
- Opportunities for students and industry to access new and cutting-edge robots and ancillary equipment – such as through Swinburne's Factory of the Future and National Industry 4.0 Testlab.
- Incentives and a fee review for robotics and STEM related courses in both vocational training and higher education while allowing to access both at a lower or no cost. This will ensure a broad participation in robotics skills training from across the community, including from traditionally underrepresented groups.

Harnessing the benefits of human-robot interactions

This section addresses question 12, 13, 21

At the centre of Swinburne's research are people working with technology - to create a better world. A key component of robotics is interactions with humans – from humanoid robots, to how robots are programmed and public perceptions of robotic systems. Research in human-robot interactions is nascent, however the value of these systems is becoming increasingly apparent. When developing autonomous robotic systems, it is vital to ensure that they are developed in ethical ways.

We have been investigating how new technologies can help in a variety of settings. In a project started in 2017, a group of people with dementia were introduced to the NAO humanoid robot with the aim of stimulating mobility and interactions amongst the group. The robot demonstrated how to hip stretches – and these exercises and dances were received positively by the group, demonstrating the seniors were interested in doing the exercises, but they did not feel like it was imposed on them.

In a similar project, this time for children, in partnership with The Royal Children's Hospital (RCH), Swinburne have been developing a socially assistive humanoid robot as a therapeutic aid for paediatric rehabilitation. The aims are to motivate young patients, increase exercise adherence and deliver rehabilitation care efficiently. After 7 years of development and testing, the robot has engaged with over 50 patients, predominantly those with cerebral palsy, and is undergoing evaluation with therapists and parents within RCH's rehabilitation clinic.

Adapting and deploying a general-purpose social robot as a therapeutic aid for diverse young patients with varying needs in a busy hospital setting comes with significant challenges. This is not typically addressed in traditional Human-Robot Interaction or robotics research generally. This project is thus exploring how state-of-the-art artificial intelligence and computer vision can be deployed long term in real-world clinical settings to augment therapy delivery and improve patient outcomes.

CASE STUDY: HRX Theatre investigates how robots can learn to be expressive through their movements by learning from human interaction and movement examples. Robots can have vastly different bodies / morphologies to humans, even as simple as a cube, yet can still be incredibly expressive in their movement, aiding collaborative exchange between human and robot. Developing more nuanced expressivity for robots will enhance their predictability and aid human anticipation of a robot's intent in collaborative situations.

Swinburne makes the following recommendations in advancing human-robot interactions:

- An increase understanding of human-robot interactions, leading to an uptake of robotics in a range of sectors including health and ageing.
- Including end-user voices and lived experiences of people using robotics/AI technologies.

Developing national robotics standards and regulations, and supporting SME uptake

This section addresses question 13, 14, 15, 20, 22, 23

A key element of enabling Australia to harness the opportunities provided by the next generation of robotics and automation capabilities is the standards and regulations that provide confidence for users. At Swinburne, we work with industry to introduce robotics and automation to primarily SMEs – and have helped more than 500 industries to date.

An emerging area within the sector is networked robotics and automation, which leverages the recent advances of information and communication technologies, such as 5G/6G, Internet of Things (IoT) and Cloud/Edge computing, for a team of robots towards collective intelligence and autonomous automation.

Robotics and automations projects Swinburne have taken on with industry includes drone applications in the mining industry – providing an innovative solution to an existing problem. This project designed automated drone inspection of equipment – rather than using scaffolding and rope access. The solution is not only safe, but will save the company maintenance costs – potentially in the millions of dollars, as inspections can be made more regularly, and don't require costly shutdowns as with the manual inspection method.

INDUSTRY CASE STUDY: Munro Engineers, an SME based in Ballarat manufactures a range of fencing machinery supplying to both domestic and international markets. They have been early adopters of robotics in their factory. To ensure process consistency and a high-quality product, they have been introducing industrial robot MIG welding cells in their factory over the last few years. These welding cells

create sub-assemblies of their products by welding child components. Each welding cell has as a separate loading/unloading station and a welding station, so the welded sub assembly can be unloaded and new parts can be loaded onto the jig while the robot welds at the welding station. Swinburne's Factory of the Future delivered an Industry 4.0 Readiness assessment to Munro in 2020, which has helped them surface opportunities for Industry 4.0 technology adoption within their business. The latest addition to Munro's robotics program is a machine tending cobot on one of their CNC machines. Munro is investing in upskilling its staff to manage and maintain their growing fleet of robots.

The service sector, including health, cultural and entertainment industries eclipse manufacturing in terms of GDP, yet robotic uptake is comparatively very low. There is enormous untapped opportunity for the development and integration of robots in these social and creative spheres. Robots need to be able to act "in the wild", in unconstrained, unpredictable environments and in very close proximity and even intimate contact with people. Issues of safety, trust, dignity, comfort and confidence are paramount in these social and cultural settings. This will require a radically multidisciplinary effort, closely incorporating STEM and non-STEM disciplines, such as humanities, performing arts and creative industries, in order to achieve meaningful human-robot collaboration in these untapped areas of society.

One way to increase acceptance and uptake of robotics in the broader community is using the lens of Robotics for social good. Within this lens, there is the opportunity to educate and include underrepresented communities in local community-driven STEM clubs and educating the wider Australian population through approachable social media, and community events. As mentioned earlier in our submission, it is important to include teachers of the younger generation and empower them to be confident to provide robotics education. We should strengthen STEM programs that include and empower girls to uptake robotics technologies related career pathways. Empower students to educate their parents from underrepresented communities and social/cultural groups about robotics and automation computer technologies. These actions will help to widen the trust and understanding of robotics technologies.

Swinburne makes the following recommendations around increased uptake of robotics and automation in Australia:

- Increased support for SMEs to upskill and implement new technologies to aid productivity.
- Support for multidisciplinary efforts, closely incorporating STEM and non-STEM disciplines, such as humanities, performing arts and creative industries to develop standards and safety to increase trust in robotic systems.

List of recommendations

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