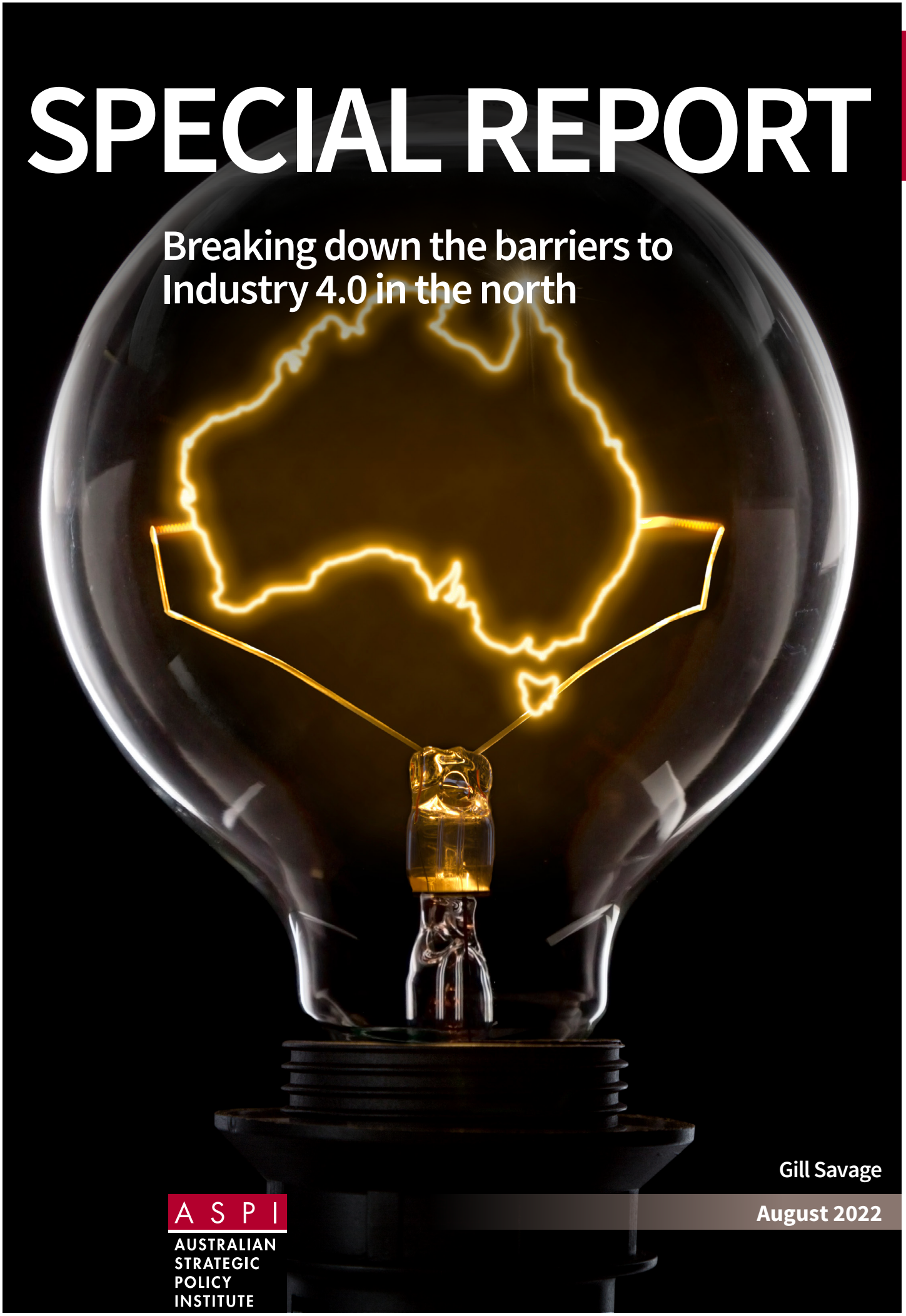
# SPECIAL REPORT

## Breaking down the barriers to Industry 4.0 in the north



Gill Savage

August 2022

ASPI
AUSTRALIAN STRATEGIC POLICY INSTITUTE

ASPI

## About the author

**Gill Savage** is a Senior Fellow with ASPI's Northern Australia Strategic Policy Centre and Deputy Director of the ASPI Professional Development Centre.

## Acknowledgement

The author would like to acknowledge the involvement and expert contributions of Grace Stanhope, Dr John Coyne and Michael Shoebridge.

## About ASPI

The Australian Strategic Policy Institute was formed in 2001 as an independent, non-partisan think tank. Its core aim is to provide the Australian Government with fresh ideas on Australia's defence, security and strategic policy choices. ASPI is responsible for informing the public on a range of strategic issues, generating new thinking for government and harnessing strategic thinking internationally. ASPI's sources of funding are identified in our Annual Report, online at www.aspi.org.au and in the acknowledgements section of individual publications. ASPI remains independent in the content of the research and in all editorial judgements. It is incorporated as a company, and is governed by a Council with broad membership. ASPI's core values are collegiality, originality & innovation, quality & excellence and independence.

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This report was produced with funding support from the Northern Territory Government.

Cover image: Australia as a lightbulb filament, iStockphoto/eyegelb.

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First published August 2022

Published in Australia by the Australian Strategic Policy Institute

ASPI
Level 2
40 Macquarie Street
Barton ACT 2600
Australia

Tel + 61 2 6270 5100
Fax + 61 2 6273 9566
Email enquiries@aspi.org.au
www.aspi.org.au
www.aspistrategist.org.au

Facebook.com/ASPI.org

@ASPI_org

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# Executive summary

There's a lot of hype surrounding Industry 4.0, but the hype obfuscates a deeper understanding, particularly about what it isn't and what's needed to support Australian innovators. Australia's brief modern history is peppered with examples of entrepreneurialism and innovation, illustrating our national potential.

To succeed, we'll need more than national potential.

Countries such as the US provide the economic and intellectual environment for innovation. Innovation incubators such as Silicon Valley don't just happen. In Australia, those inputs are lacking, but more remote locales are driving a new generation of innovators. Necessity is ensuring that innovators in northern Australia are making a prominent contribution.

This is a report about how innovators in the north are at the leading edge of the fourth industrial revolution and the challenges they face.

Innovation in northern Australia is thriving. It's not clear why there's a culture of innovation in the north, and perhaps that represents a focus for social research. However, there's no doubt that innovators in northern Australia are seizing the opportunity to pursue solutions that generate economic benefits, contribute to national resilience, and respond to defence needs.

Through the lens of real experiences and success stories, this report shines a light on the opportunities and challenges, and highlights what's needed to better harness those opportunities. In particular, we need to do these things:

- Drive national capability through a philosophical positioning that's supported by practical examples of innovation.
- Acknowledge that economic theory underpinned by a need to have large-scale manufacturing and production lines for viability is thinking not aligned with the opportunity that Industry 4.0 presents.
- Align government thinking and practice with the growing environmental, social and governance (ESG) mindset of business and the growing expectations of investors, consumers and the community.

The case examples in this report illustrate innovation that's already occurring in the north, often with the support of future-thinking state and territory governments. However, those aren't overnight successes—the assumptions we make about innovation are flawed. It's important to appreciate that innovation is underpinned by trial and error, failure and persistence, long lead times and an unwavering commitment to a better future.

Still, more is needed! This report proposes changes to ensure that northern Australia can continue to leverage Industry 4.0 opportunities and sustains its innovation focus.

# Industry 4.0 is here

In the report *New beginnings: rethinking business and trade in an era of strategic clarity and rolling disruption*[1] ASPI noted that the fourth industrial revolution, Industry 4.0 is accelerating:

> … fundamental changes to every corner of 21st-century life. This is more than the arrival of all-new technology but is also about convergence and connectivity. With it have come all-new economic opportunities, and things were looking good until the arrival of Covid-19. The traditional business theories that value efficiency, effectiveness, profit maximisation, just-in-time production and logistics as core cost-reduction strategies, vaguely defined concepts of globalisation—orbiting around assumptions about the retreat of the significance of the sovereign state—have been tested by the twin arrivals of Covid-19 and coercive Chinese power and found to be wanting.[2]

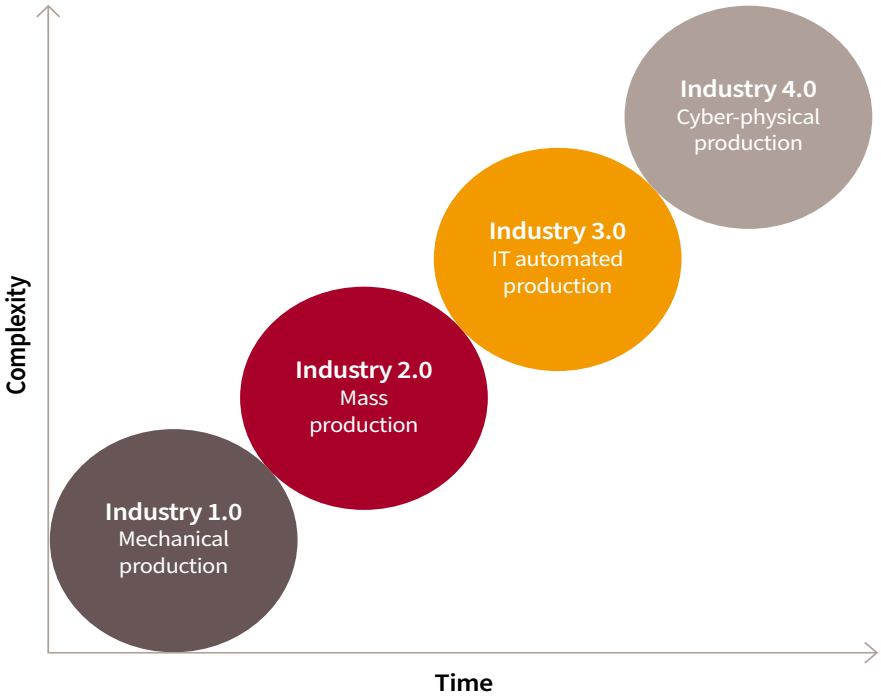
But what is Industry 4.0?

Industry 4.0 spans the adoption of improved automation, machine-to-machine and human-to-machine communication, artificial intelligence, continued technological improvements and digitalisation across all sectors, including manufacturing and government services.[3] It enables small-scale, point of distribution or use production and tailored products to meet specific needs. This is a fundamental shift from the engineering era of mass production of standardised systems in lowest cost locations combined with global distribution from those centres of mass-scale production.

Figure 1 illustrates the evolution of industrial development, beginning with the 'mechanical production' of the first industrial revolution through to the 'cyber-physical production' of today and beyond. The first revolution occurred from the late 1700s through to the mid-1800s, with a shift from hand production to machines powered by steam engines that transformed many sectors, including cotton production. Industry 2.0 was all about mass production efficiency and institutionalised 'minimum production run' thinking. Industry 3.0 took a step further and leveraged automation technology to achieve efficiencies of scale through bigger production runs and shorter time frames.

Today's challenge is a different one. There's a need to shake off the now outdated focus on automation driven through Industry 3.0 and institutionalised through the 'cult of the MBA'[4], and embrace transformative thinking enabled by Industry 4.0 technology.

Figure 1: Global industrial revolutions to date




Source: *Transforming Australian manufacturing: preparing businesses and workplaces for Industry 4.0, PWC*, May 2019, online.

The shift is difficult to conceptualise, and even Figure 1 implies that it's linear. However, Industry 4.0 was emerging prior to the full adoption of Industry 3.0 and it will co-exist with that earlier form of design and production.

Industry 4.0 represents opportunities to transform, but it's not just about developing and adopting smart technology. And it's not about evolutionary or transformative change. Industry 4.0 is a different way of thinking that will allow us to leap into a different future. To reap the transformative benefits from Industry 4.0 we need to adopt leading-edge technology in the best way to deliver better outcomes from the perspective of a wider range of interests. That means rejecting traditional and outdated paradigms such as an overly restricted focus on efficiency without factoring in resilience and the ability to operate in times of crisis and disruption to wider distribution and production systems. We need to challenge everything that has come before.

For example, traditional manufacturing is based on production runs and batches. However, central to Industry 4.0 is the opportunity to 'produce a *batch of one* through highly flexible and intelligent manufacturing processes' that are 'enabled by a production line communicating and adjusting in real time to mass produce a unique product'.[5] This change represents a more holistic assessment of 'effective and efficient' that shifts away from the centralist, mass production approach into a nimbler and more distributed concept. This concept is almost essential for success in the fracturing global economy that's already evident. It's likely to become more obvious across more sectors and functions, given the effects of the pandemic, an assertive China, technological change, and now the return of war in Europe and the rise of the working strategic partnership between Moscow and Beijing.

There are many examples of Australian companies investing in Industry 4.0, including Dulux Australia, which in 2018 opened a '$165m, highly automated paint factory' to become the 'largest coatings factory in Australia, allowing Dulux to step into the next generation of paint manufacturing technology and innovation'.[6] This is a highly automated facility with next-generation systems controlling five fully automated filling and production lines taking in more than 150 raw materials to deliver 1,200 individual products.[7] This isn't just about better handling of multiple inputs to create a larger number of products. It's about adopting smart infrastructure early to enable a wider range of future possibilities.

The need for this shift in paradigm is important for governments to appreciate and actively pursue. Market forces, including shareholder capitalism, with their shorter term focus won't, on their own, nurture this new thinking. Since 2019, the interplay between economic prosperity, resilience and national security has become increasingly apparent, and that will continue. Therefore, the need to embrace and accelerate the adoption of new ways of thinking, creating and living is more important than ever.

'The value of an idea lies in the using of it.'
—Thomas Edison (1847 – 1931), inventor[8]

## Better use of natural resources

Often, the focus of Industry 4.0 is on reaping productivity benefits arising from reduced resource inputs. Such opportunities are real, but they're only part of the picture. The big opportunity is in reimagining outdated manufacturing processes. Shifting our mindset will enable us to modernise Australia's economic and commercial landscape, making once unprofitable activities viable. Moving from 20th-century lean process management focused on improving inefficient processes and reducing process waste will change the way new ideas are brought into reality.

The fashion industry is an example of a particularly 'wasteful' sector. The UN's Act Now for Zero-Waste Fashion program [9] in support of the Sustainable Development Goals highlights that 2,700 litres of water is needed to make a cotton shirt and 9,982 litres of water is needed to produce a pair of jeans. The fashion industry:

- produces 20% of global wastewater[10]
- is responsible for 8%–10% of the world's greenhouse gas emissions[11]
- loses $500 billion of value every year due to clothing underutilisation and lack of recycling.[12]

What if we were able to create the exact number of clothing items we needed, when we needed them, and near where we wanted them, from exactly the precise number and quantity of inputs (water, natural resources, labour and so on) and infrastructure (such as facilities and investment)?[13] This aspect is important for those operating in Australia's north: the scale of markets in the north isn't large, so insufficient demand means oversupply if we rely upon traditional manufacturing.

This raises a further challenge to the sales-driven retail sector that has emerged in recent decades. Focused production is dependent on consumers purchasing at the retail price rather than waiting for heavily discounted sales pricing. This is a cultural change because consumers have learned that the first price isn't the 'real' price.

Despite this challenge, Industry 4.0 means that a different approach for the fashion industry, and other sectors, is not only possible but likely. It shows the promise of point-of-distribution production and of smaller production runs tailored to specific customer demands, using a design process that's much more responsive to changing consumer demands.

## Enhanced economic performance

Australia's economic prosperity is dependent on understanding the potential of Industry 4.0 today, rather than yearning for a 'never-was' 1970s manufacturing utopia or discounting Australia's ability to manufacture systems because of the experience of industries such as domestic car production. Those aren't useful models for what's now possible from Industry 4.0 and what's required from the fracturing world in which we're living.

In addition, the impact of labour as a percentage of manufacturing has been drastically reduced through Industry 3.0, and that will be accelerated with Industry 4.0. This means that the drivers, especially as they apply to lean management approaches evident in past decades through offshoring and centralisation, are increasingly less

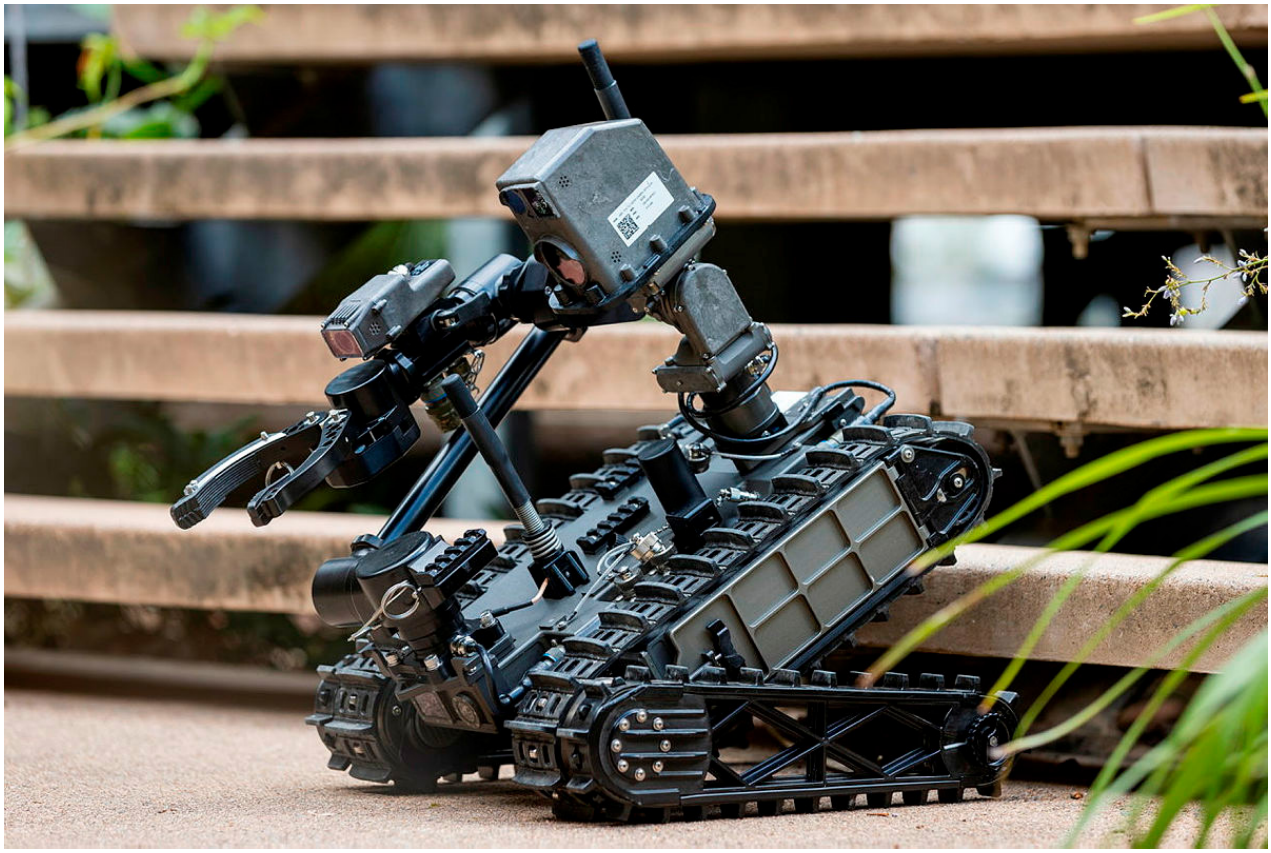
valid. New drivers (such as resilience and access to supply during times of disruption, crisis and even conflict) are now also relevant to planning, investment and decision-making.

Governments and businesses need to go beyond adopting 'Industry 4.0 technologies and ways of working specific to the needs of their business'[14] and move towards adopting Industry 4.0 enablers. That includes embracing rising data volumes, computational power and connectivity; adopting emerging analytics to inform business intelligence; creating new forms of human–machine interaction; and improving the transfer of digital instructions to the physical world.[15] Centres that pool key assets (such as that being built at western Sydney's Aerotropolis) to enable small and medium-sized high-technology firms to test design and production are examples of what's required for success.[16]

We also need to reject the jobs lost/gained equation. The jobs in Australian manufacturing were lost in decades past. Industry 4.0 is an opportunity for jobs growth. However, a shift in workforce capability is required that in part will be met through transitioning workforces from obsolete sectors to tech-driven ones.

Workforce capability is a key focus of the North Queensland Simulation Park (NQ Spark)—the first collaborative industry hub in northern Australia. NQ Spark's goal is to be a 'leading centre of education, training and research commercialisation'. The centre will bring together regional science, defence, health and knowledge expertise into an 'advanced environmental simulation facility and technology-orientated collaborative precinct'.[17]

**Figure 2: Squad packable utility robot during trial phase at Lavarack Barracks, Queensland, 2021**



Source: Department of Defence, online.

## Risk versus opportunity

It's easy to appreciate the opportunity that Industry 4.0 represents. However, that opportunity is hampered by traditional risk frameworks used to guide innovation investments.

The Future Fund has the role of being 'Australia's sovereign wealth fund, responsible for investing for the benefit of future generations of Australians'. It was established in 2006 to 'strengthen the Commonwealth's long-term financial position' through the management of public asset funds including the:

- Future Fund
- Medical Research Future Fund
- DisabilityCare Australia Fund
- Aboriginal and Torres Strait Islander Land and Sea Fund
- Future Drought Fund
- Emergency Response Fund.[18]

The Future Fund has adopted an ESG policy[19] that integrates ESG factors (including occupational safety, human and labour rights, climate change, sustainable supply chain, corruption and bribery) into investment decision-making through:

- partnering with external investment managers
- direct asset investments having regard to assessments of ESG and reputational risk issues
- exercising ownership rights to foster good governance and value creation over the long term
- engaging with investee entities through oversight and management accountability
- contributing to a stronger investment system through system integrity, protecting investor rights and building new markets.

However, it's important to appreciate that the purpose of the Future Fund is also to prevent brain and intellectual property (IP) drain as well as to supply the equity to promote innovation that isn't available through the traditional commercial investment market.

The Future Fund 2020–21 annual report notes the investment mandate for the Future Fund is to achieve an average annual return of at least the Consumer Price Index (CPI) + 4.0% to 5.0% per annum over the long term, with an acceptable but not excessive level of risk.[20]

The emphasis on 'acceptable but not excessive level of risk' is open to interpretation. While the Future Fund management team acknowledges that climate change, for example, 'presents risks and opportunities', it's clarified through the ESG policy in an unexpected way. By way of explanation, the Future Fund considers 'material climate risks in our investment process' through emphasis on:

- *carbon price risk:* there are risks that markets in which we invest will introduce a price on carbon emissions
- *transition risk:* the risk of potential changes in regulatory standards, public policy, technology and customer preferences in response to climate change
- *physical risk:* the risk of damage or disruption to assets, supply chains and economies more broadly from changes in weather patterns, both acute and chronic.[21]

Disappointingly, this framing emphasises risks over opportunities. Innovation is about taking new and different action. In taking new action, we're rejecting traditional risk frameworks.

The public expects that a 'future fund' is at least partly about 'picking winners', and so the governance mechanisms and risk managers need to respond appropriately. However, picking winners in the innovation game isn't easy. We need to accept that innovative opportunities assessed through traditional risk frameworks will have a higher risk rating, but there's also potential for far greater returns. Innovation can fail, but so too can investment in lower risk, outdated opportunities.

Exploring the patents held by the 19th-century inventor Thomas Edison provides an interesting counterpoint to today's approach to innovation:

> Edison held 1,093 patents for different inventions. Many of them, like the lightbulb, the phonograph, and the motion picture camera, were brilliant creations that have a huge influence on our everyday life. However, not everything he created was a success; he also had a few failures.
>
> Edison, of course, had a predictably inventive take on the projects that didn't quite work the way he expected. 'I have not failed 10,000 times,' he said, 'I've successfully found 10,000 ways that will not work.'[22]

Why do we expect low-risk thresholds and certainty of success for present-day innovations?

The NSW and Victorian governments are pursuing what in many ways are considered the next-generation programs to support Industry 4.0 take-up.

The NSW Government is leveraging the Western Sydney Airport development to reimagine urbanisation. With a focus on livability, the Western Sydney Aerotropolis encompasses three precincts:

- Aerotropolis Core, Badgerys Creek and Wianamatta – South Creek Precincts, which are a combination of green corridors and recreation facilities alongside logistics, commercial industry, high-technology industry and associated employment uses.[23]
- Agribusiness Precinct, which will 'support the production and value-adding of sustainable, high quality fresh produce and pre-prepared consumer foods' and 'accommodate up to 10,000 jobs by 2056'.[24]
- Northern Gateway Precinct, which 'will become a hub for manufacturing, warehouse and distribution functions'.[25]

Through the Breakthrough Victoria program,[26] the Victorian Government is investing $2 billion over 10 years 'in industries that will create the jobs of tomorrow' through 'future-focused' investment that prioritises 'sustainable, long-term investments' and is 'fast-tracking, commercialised innovation' to support the 'economy, create jobs and improve lives'. Investment is across four funding streams:

- Foundational Technology and Platform Projects, which focuses on technology, research or infrastructure for start-ups in emerging industries.
- Creating the Pipeline, which invests in early-stage ideas in the development of protypes, proof-of-concept trials etc.
- Catalyst for Change, which invests in companies that have demonstrated early market traction.
- Catalyst for Growth, which makes long-term investments in the scale-up of Victorian companies.[27]

It's still early days, but the Breakthrough Victoria program appears to provide the most practical and accessible investment opportunities for Industry 4.0 innovators and entrepreneurs.

## National resilience as the driver of innovation

Prior to 2019, the focus on national resilience was the domain of risk practitioners who were voices in the wilderness highlighting an impending doom that many of us couldn't perceive or imagine. Much has changed in the past few years, and national resilience has become the explanation, the justification and the solution for almost everything we don't fully understand. Few have seen innovation as a power for positive change that has the potential to supercharge an economy and produce the resilience we now know we need in times of disruption and crisis.

In northern Australia, this has been the case for some time. The link to supply-chain vulnerabilities is most prominent and one that needs urgent action.

In June 2021, Ulas Yildirim insightfully noted the extent of the impact:

> … lack of resilience in the semiconductor supply chain has exposed vulnerabilities in the commercial sector, such as car and mobile-phone manufacturing. But it has also exposed military operations around the world because Taiwan is the sole producer of the Xilinx chips used in the F-35 joint strike fighter. This illustrates the deep connections between commercial and public interests when it comes to national defence.[28]

This also highlights the vulnerabilities inherent in the supply-chain thinking and practice of the past 30 years. Covid-19 has demonstrated that we were overconfident about the benefits of globalisation: we convinced ourselves that the global economy was too big to fail.

In August 2021, I highlighted that rare-earth magnets provide a current example of how Australia is 'failing to search creatively for a solution'. Reliable domestic supply would drive further high-value technology and high-value products. Australia has significant reserves of critical minerals essential to manufacturing advanced technologies such as electric vehicles, mobile phones and renewable energy systems. However, despite opportunities for Australia to become a producer and manufacturer of critical minerals and rare earths, the global market is dependent on China, which dominates supply chains for over 80% of the global rare-earths market. This positions China to build the economic power that could block Australian companies from competing internationally. A dependency that raises challenges for our national security, sovereignty and economic prosperity.[29]

China's dominance in the market changed the commercial return for Australian companies, but we've seen with recent shortages of AdBlue[30] and increasing fertiliser prices that the greatest risk arises when a trading nation makes unexpected and quick policy changes.

In September 2021, ASPI stressed that modern nation-building 'starts with rethinking business and trade to mitigate the risks of coercive trade, optimise national resilience and take advantage of national strengths and trusted partners. Our current well-worn policies, procedures and mindsets were designed for a different, less challenging and slower paced era.'[31]

It's important to appreciate that supply-chain issues 'represent a convergence of factors that have a limited effect in isolation but, when combined, significantly impact sovereignty and national resilience' and that 'we are yet to come to terms with them as critical elements of sovereignty and national resilience.'[32]

This isn't about addressing every vulnerability in every supply chain. Nor is it about creating a new supply chain or resilience 'focal point' within the bureaucracy. It's about articulating what we, as a nation, value most, and understanding how changes to those things we value position as supply-chain risks.

# There are barriers

The barriers to Industry 4.0 are familiar. However, unaddressed, for Industry 4.0 they'll be crippling and will inhibit industry across all sectors:

- *Investment.* Industry 4.0 needs to be supported by equity investment and anchor clients. Without one, you can't get the other, and capacity needs consistency in demand. The market reality is that raising equity or debt is risky if there's no commitment to ongoing use. Australian innovators are often faced with the choice of selling out, moving offshore or losing the house, often because potential anchor clients won't confirm their commitment.
- *Mindset.* There appears to be a fear of letting go of the thinking of the past three decades. The risk mindsets of departments and governments, coupled with shareholder capitalism, drive a disproportionate focus on prospects of failure over success and, in the corporate world, on the next quarter's profit and share price. This can and needs to be rebalanced by company directors reweighting those shorter term issues against their need to ensure the long-term viability of the company.
- *Policy.* ASPI's *New beginnings: rethinking business and trade in an era of strategic clarity and rolling disruption* report highlighted that Australia's federal, state and territory governments need to inject a national security perspective into decisions and policies that influence Australia's economy. That perspective must consider two clear focuses: resilience and sovereignty, each of which is best pursued in trusted partnerships with those who share our interests.[33] This is particularly relevant to fostering Industry 4.0 in the north.
- *Cultural.* Unwillingness to fail, low risk appetite, or both, are key barriers to innovation, as is the notion that failures are almost certain along the path to success. Persistence and learning from failures are hallmarks evident in the rise of most technology firms that are now household names. Again, the current emphasis continues to be on minimising risk despite the reality that doing something differently or doing something new is inherently 'risky'.

> 'Creativity is thinking up new things. Innovation is doing new things.'
>
> —Theodore Levitt (1925–2006), economist[34]

- *Confidence*. Cultural cringe continues to be alive and well in Australia. Michael Lucas of Engineers Australia notes, 'Although a lot of robotics technology is developed in Australia, local businesses tend to buy their products overseas. They want to see someone else use them first.'[35] Ask any budding innovative entrepreneur and they're likely to agree that we lack the confidence to invest in homegrown technology, although we're happy to buy it once it's been sold to someone to produce overseas. To fast-track the take-up of new products and technologies, we need to rethink service guarantees and after-sales arrangements.
- *Process maze.* Start-ups and small to medium-sized enterprises (SMEs) are confronted with a maze of inconsistent processes and no clear pathway, resulting in a lack of engagement with subject-matter experts. Box-ticking approaches result in innovation being overlooked.[36] That's why initiatives such as NQ Spark, Breakthrough Victoria and the NSW Government's Aerotropolis high-technology centre are so refreshing.

The barriers here aren't new; however, Industry 4.0 raises them to a new level of obstruction. Change is needed. Along with the examples covered already, positive outcomes are being driven by governments in the north connecting innovators and investors and fostering relationships between innovative industry and Defence, but much more is needed.

# The north is good at innovating

In my November 2021 article in *The Strategist,* I noted that:

> Industries, manufacturing and agribusiness in the north need to reimagine their operating models and pursue new ways of doing business based on the opportunities that Industry 4.0 offers. More of the same, or even incremental improvement through adoption of technology, is no longer enough and won't drive scaling.[37]

Innovating in this space will always require a degree of perseverance and a measure of good luck. Still, governments do have the ability to shorten the odds for success.

The good news is that there's a culture of innovation in the north. It's driven by necessity and arises from the tyranny of long supply chains and a small industry base.

Of course, the north isn't alone in its pursuit of sustainability-focused innovation in Australia, but it's a stand-out. Often, ESG initiatives are driven by big corporates responding to consumer sentiment and shareholder expectations. The difference in the north is that innovators are often driven by the desire to pursue environmental, social, sovereign and security outcomes as a bundle. It's possible that the reality of the harsh investment and business environments fosters a more community-minded culture.

The following examples describe how innovators in the north are leveraging Industry 4.0 opportunities.

## Life h2o Australia

Life h2o Australia is a Darwin-based Australian company that has developed a suite of military-grade water-purification equipment, including person-portable trunk units, backpack-sized systems that can be carried by a single soldier and much larger units designed to use mechanised transport.

The benefit of the Life h2o innovation to the ADF is that it eliminates the need to issue bottled water. It also has flow-on benefits, including a reduction in resource use, plastics generation and plastic waste. The benefit for defence forces is that it reduces their logistic trains, operational vulnerability, signature and footprint. That improves soldier flexibility, sustainability and survivability, providing strategic and tactical advantages that support positive and effective mission outcomes.

This company is another example of a growing number of innovative businesses in the north that have a demonstrated commitment to providing 'essential resources, operational support and sovereign capability to organisations such as the ADF, allied forces, the Australian Border Force and emergency services and to provide assistance for humanitarian aid efforts and natural disaster responses in Australia and the Indo-Pacific region'.[38]

A great innovation success story, but there are still commercialisation challenges. While the ADF likes the units and systems that have been deployed in overseas operations and field training exercises for operational testing, the commitment to embrace innovation is a cripplingly slow process for SMEs.

The application of the Life h2o technology goes beyond the defence and security sector and into the multi-use arena. Existing water sources and renewable energy can be used to provide a clean, safe water supply for human consumption, to support medical services, and as a prevention measure to combat waterborne disease.

This technology could be implemented in remote Australia to provide potable water fast and at low cost in comparison to traditional reticulation. In the face of a vast array of health problems, including renal failure rates up to 30 times the national average in some remote Indigenous communities, the health, social and economic benefits arising from a lower incidence of water-quality-related health issues would be significant.

We've seen a wider national need for safe water in the damage and dislocation caused by widespread flooding in eastern Australia, so solutions for the ADF to operate in the north may turn out to have wider national benefit and will also have potential application in the South Pacific as part of mitigating the human impacts of climate change.

## NT Ship Lift Digital Twin Project

'Digital twin' is a key enabler of Industry 4.0—it allows every aspect to be designed, built and tested in a virtual world before it's produced in the physical world.[39] The benefits include improved stakeholder engagement, faster prototyping, using only the required natural resources, eliminating production waste and carbon emissions, and reducing go-to-market time frames and costs.

Governments across Australia are already embracing the opportunity for digital twins to greatly improve the planning and design of infrastructure investment and community amenity. The Northern Territory Government has partnered with Secora APII and Dassault Systemes in the application of digital twin technology to visualise future development of Darwin Harbour, which includes the redevelopment of HMAS Coonawarra and the emerging Marine Industry Park centred on a new common-use facility and ship lift.

Through a combination of layered infrastructure, environmental datasets and virtual reality technology, possible future operating scenarios can be 'tested' via the digital twin to ensure that projects derive appropriate capability, are primed for on-time delivery, and can be confident of available utilities, transport and personnel as they reach commissioning.

## SPEE3D

Companies are already reconceptualising the manufacturing and production lines of the last century. Darwin-based SPEE3D produces industrial-quality metal parts for defence, agriculture and industry applications in a fraction of the time by using metal cold-spray technology in 3D printing. The benefits are smaller, targeted production runs that use fewer resources and minimise whole-of-life-cycle waste.

The potential for 3D printing to reinvent and revitalise manufacturing in Australia is enormous. This isn't just about advanced technology: it's a new way of thinking about manufacturing that's being made possible by Industry 4.0 tech.

## HyperOne

The construction of a 20,000+ kilometre, $1.5 billion hyperscale national fibre network by Queensland-based HyperOne will create more than 10,000 new jobs during construction. When complete, it will support tens of thousands of jobs nationally in cloud computing, data centres, the environmental sciences, space vehicle launches and the aerospace, satellite and defence industries, and service local distribution networks such as the National Broadband Network and mobile operators.

## Sun Cable

Australian innovators are rethinking and reshaping how we do things and who does them. They're building solar farms to generate power not just for domestic use but also for export. This investment encompasses export opportunities for strategic services such as Sun Cable's Australia–Asia Power Link Project,[40] which will export renewable energy from the Northern Territory to provide up to 15% of Singapore's electricity supply (Figure 3).[41]

Sun Cable isn't just exporting energy via an undersea cable; it's creating the possibility of an electron-exporting business. This is a deliberately focused export market, but challenges would arise if the energy generated is ever needed for sovereign purposes.

Figure 3: Australia–Asia Power Link


Source: Sun Cable Pty Ltd, online.

## Tritium

Tritium Holdings Pty Ltd is a global developer and manufacturer of electric vehicle (EV) chargers that's headquartered in Brisbane. Tritium was first in the world to implement Plug and Charge (ISO 15118), which enables EVs and charging equipment to communicate, authenticate and transact seamlessly via the charging cable.[42]

In 2019, Tritium established a joint venture between Daimler, Ford, BMW Group and the Volkswagen Group with Porsche AG to unveil the next-generation charger, which was engineered, industrialised and manufactured by Tritium.[43] In 2021, Tritium was listed on the Nasdaq with an enterprise value of $2.2 billion and around $390 million on the balance sheet.[44]

Tritium is a hugely successful Australian innovator and a success story that's been 20 years in the making, and which is underpinned by Australia's smart-nation credentials.

# Additive manufacturing

While Industry 4.0 enables us to reimagine new manufacturing opportunities, it also presents the opportunity to reshape existing sectors. This is particularly the case with additive manufacturing which is the application of 3D printing to:

- create on-demand repair or replacement of components
- customise and reverse engineer
- create otherwise impossible product solutions.[45]

Not only does additive manufacturing tackle wasteful and outdated replace-when-worn thinking and practices, it provides opportunities to significantly extend the life of components and parts across agriculture, defence and manufacturing.

DMTC Limited (formerly the Defence Materials Technology Centre) was established in 2008 under the Australian Government's Defence Future Capability Technology Centre Program (Figure 4). DMTC is using additive manufacturing as a repair technique to turn worn materials into an 'as new' standard. In 2019, DMTC successfully developed and demonstrated laser additive technology used to repair damaged high-strength steel aircraft components.[46]

**Figure 4: Field trial of corrosion prognostic monitoring system for Anzac-class frigates run by DMTC aboard HMAS *Parramatta* in 2018**


Source: Department of Defence, online.

DMTC has also partnered with CSIRO and ASC Pty Ltd to develop a form of additive manufacturing—a cold-spray technique—that will allow Australian submarines to remain at sea for longer. Cold-spray techniques use a stream of supersonic gas to accelerate metal powder particles onto a surface, building up a dense deposit. Given that the process occurs below the melting temperatures of the metals, it avoids damaging the structural integrity of the components and surrounding area.[47]

# Advanced manufacturing, here we come!

Industry 4.0 presents many opportunities in areas that we often characterise as barriers or challenges. Reframing how we think about Industry 4.0 allows us to tap into potential workforce opportunities, solve problems faster and leverage our service and delivery strengths.

Australia's Modern Manufacturing Strategy aims to:

- establish the economic conditions right for business
- make science and technology work for industry
- focus on areas of advantage
- build national resilience for a strong economy.[48]

The strategy states that Australia is ranked fifth in the OECD for innovation in business and is in the top 10 countries globally for the availability of skilled labour.[49] Being fifth for innovation is a great achievement, but we should strive for more. Sadly, tenth in the skilled-labour stakes is nowhere near good enough.

## Job design

For employers in southern Australia, our Covid-19 experiences have highlighted what employers in the north have known for a long time: employees are motivated by more than a decent wage and a job title. The Future of Work Institute at Curtin University has identified the key aspects that underpin SMART work design:[50]

- Stimulating work that involves skill variety, task variety and problem-solving demands
- Mastery, which is the degree to which your job provides role clarity, feedback and task identity
- Agency, which is about the extent to which you can influence your own schedule, choose the way you will achieve work goals, and make work decisions
- Relational, which is about the sense of support, purpose and social contact at work
- Tolerable Demands, which is the extent to which a job involves time pressure, emotional demands and role conflict.

For Australia to be an Industry 4.0 success story, we need to rethink job design and embrace the potential of a more diverse and geographically dispersed industry base. For the first time since the 1970s, this creates the possibility of a far more geographically dispersed workforce that could well see a Sydney-based company having employees working in Cairns or anywhere in between.

Our Covid work-from-home requirements have proven this is not just possible but also drives significant productivity and wellbeing benefits. And remote working isn't confined to unclassified working environments. For the UK's Government Communications Headquarters (GCHQ), 'Covid-19 became the catalyst for different ways of working, enabling more work at lower classifications and working from home.'[51]

## Solving problems

Plato is credited with saying 'Our need will be the real creator', which over time evolved into the English proverb 'Necessity is the mother of invention.'[52] There's nothing like having a real problem to solve to drive new ways of thinking and doing.

Smart phone apps and rideshare are an Industry 3.0 case study. The apps weren't developed to solve a dissatisfaction problem some users had with taxi services. However, through their application to personal transport they now underpin the ride-sharing economy and will continue to support the evolution of 'mobility as a service'[53] by facilitating access to multiple transport modes for a single journey (for example, by integrating public, private and active transport options).

This example shows that it will be some time before we fully appreciate the scope and scale of the opportunities that Industry 4.0 will enable us to seize. Often, we don't know that we've been innovative until we look back at the impact the innovation had.

The biggest challenge we face is that we don't have decades to develop solutions for today's complex problems. And if we don't get ahead of today, we'll never get onto solving emerging or future problems. We need to apply smart technology in a smart way to practical problems. This requires us to frame our current problems differently and resolve them with a level of urgency.

## Great service and support

The services sector contributes 79% of value added and 88% of employment to Australia's economy[54] and makes around 40% of our export earnings.[55] The sector is diverse and spans a range of other sectors (including health, cleaning, tourism and hospitality), with the exception of the goods sector (mining, agriculture and manufacturing).

There's been significant growth in the services sector since the 1950s and that has displaced manufacturing as a prominent contributor to Australia's economy. Business services continue to be a prominent services growth area as companies increasingly outsource IT development and network management, finance management and logistics. The benefits of those services include increased productivity through greater economies of scale, greater specialisation and improved quality. However, lower growth in productivity and capital investment has been experienced in more labour-intensive and face-to-face services,[56] and some Australian services (such as hospitality and tourism) have been severely affected by Covid-19 response measures, including state and national border closures.

The scale of the Australian services sector is comparable to the scale of the sector in other OECD countries, but there's also concern that there's poor productivity performance in all OECD countries.[57] While productivity performance is often measured via hours worked and output per unit of labour, it's difficult to measure the 'quality' of our national services sector or compare it to that of other countries. That said, Australia does appear to have a positive reputation in the services sector relative to other nations, but it's risky for any nation to rely on one strong sector.

## Deliver, deliver, deliver

Australia is good at delivery, too, but we often don't have the confidence to invest locally and demonstrate our delivery capability. What that means in practice is that innovators are forced to look overseas for equity investment and, in the process, are often faced with the requirement to commit to overseas production and delivery. However, the reputation of Australia's technology innovators isn't matched by their overseas counterparts. Silicon Valley, for example, has a reputation for hype at the expense of focused execution.

Australian innovators, particularly in the north, have a commitment to Australia's economic prosperity, resilience and national security. This means they hold a strong preference for local investment, which drives many to reject the opportunity to head overseas.

The key issue is the need to de-risk Australian innovation. This could be achieved through a sovereign wealth fund with more appropriate risk positioning that underwrites leading-edge, SME-led sovereign innovation.

**Figure 5: DMTC is working with RUAG Australia and Australian research partners to advance laser additive deposition (LAD) technology, which is a highly efficient repair process for aerospace components that offers significant cost and lead-time advantages over replacing the part**

Source: © DMTC Limited. Photographer: Mike Baker.

# Displacement is the new black

For Australia to fully embrace Industry 4.0, we need to accept targeted displacement rather than settle for the slowness of continuous improvement or randomness of transition. We need to accept that some industries will fade away and new ones will spring up in their place. But new industries must be supported by long-term commitment and investment. We need to decouple Industry 4.0 investment from short-term, politically driven 'announceables'. Reinforcing and celebrating success is a more durable approach, as it recognises and reinforces the conditions and environment that have enabled success.

There are four key conditions for this displacement to succeed:

- *Accelerate innovation.* More and faster innovation today will deliver more and sustainable innovation for the long term.
- *Transform investment.* We need to recalibrate our thinking on investment risk by placing equal emphasis on opportunity. This requires making decisions based on the tangible and intangible costs and benefits over the short, medium and long terms. Let's put to bed the current philosophy, which places greater emphasis on short-term activity and 'busy-ness'.
- *Rethink the skills and expertise developed through vocational training.* Not everyone needs a degree, but key trades do need an understanding of the potential of Industry 4.0 and the technical expertise to leverage it. This is particularly relevant for today's electronic, electrical and building apprentices. To a large extent, the workforce of the future is here—but it needs upskilling.
- *Stop getting hung up on labour costs.* This is a hangover from traditional manufacturing and it's no longer relevant. Faster, targeted production and less waste reduce production costs, which allows reinvestment in smart workforces. Smart innovation is underpinned by a smart workforce that's set to grow under Industry 4.0.

## Mainstream paradigm shifts in thinking

Advanced manufacturing isn't just about new technology. As we've seen with SPEE3D, the big impact arises from rethinking and reimagining, and then applying technology as an enabler of disruption rather than an end.

Australia prides itself on being a can-do nation, but we have a two-speed economy with a growing chasm between traditional industry and the entrepreneurs who are driving sustainable outcomes on a global scale. Those entrepreneurs span all sectors and are representative of all age groups, but they experience similar barriers related to perceptions of risk, access to investment and the expectation that innovation must deliver big results in the short term.

# Change what now?

The continued success of Industry 4.0 in the north requires a willingness to address systemic barriers, accept risk and failure, and foster an environment unlike any we've previously envisioned. Four areas that require change are discussed here.

## Overhaul 'right to repair' arrangements

Australian consumers have access to a 'right to repair' in relation to purchased products through a range of policies (such as consumer and competition law), intellectual property protections, product labelling, and environment and resource management arrangements.[58] The Productivity Commission's 2021 *Right to repair* report stated that, while there's 'no evidence of a systemic competition problem across all repair markets', there is evidence that 'manufacturers are limiting third-party access to repair supplies (such as information, tools and parts)'.[59] The significance of those findings is that they identify market access barriers for independent repairers that inhibit the widespread adoption of additive manufacturing.

Such access barriers are prominent in the agricultural sector and the mobile phone and smart device markets. The impacts on farmers and consumers are higher repair prices, reduced access and choice and greater financial risks from repair delays.[60] Many smart device users already have firsthand experience of the challenges in repairing a cracked screen or replacing a faulty battery.

The Productivity Commission concluded that there are opportunities for greater access by independent repairers and recommended that the Australian Government should:

- require suppliers of agricultural machinery to provide access to certain repair supplies to reduce the harm of the pervasive barriers to accessing those inputs
- undertake more detailed investigations into specific product markets (including mobile phones and tablets, and medical devices) to better understand the extent of harm and examine whether additional regulation would yield net benefits
- amend copyright laws to facilitate the accessing and sharing of repair information (such as repair manuals, and repair data hidden behind digital locks).[61]

While those recommendations are welcome, urgent action is needed to ensure that the north maintains its current competitive Industry 4.0 positioning, and that the repair costs for farmers, businesses and consumers are reduced to enable them to recover from the economic impacts of Covid-19 and extreme weather events.

## Rethink and redefine

Mass production is a construct of the first industrial revolution that has little relevance to Industry 4.0. It's unhealthy, wasteful and inefficient.

Aside from their scale advantages, conventional production processes also have downsides, including that they generate pollution, result in workplace health and safety problems and are resource intensive. Our response over the decades has been to legislate as a means of managing and controlling the impact of mass production. The case example above highlights the wastefulness of the clothing sector in terms of resource use and the volume of clothing items that end up in landfill. However, other mass-production processes are equally wasteful when you consider a minimum production run for a particular product or model. Multiply that by several brands and many models within each brand and that's a lot of potential waste.

Despite those limitations of traditional manufacturing, the supply-chain deficiencies we've experienced during the Covid-19 pandemic and extreme weather events are generating a desire to return to 1970s-style manufacturing. It seems that whenever a supply-chain issue arises, we lament the loss of Australia's manufacturing sector, review

the (bad) decisions that got us here and conclude that Australia needs to manufacture (almost) everything as a way of bolstering resilience and protecting our sovereignty.

Australia's recent AdBlue shortage is an example of the overly positive 'rear view' we sometimes take.[62] That issue resulted from a confluence of simultaneous factors, from decisions by China to increase local access to urea (thereby reducing urea available for export) to the need to increase the use of AdBlue in diesel vehicles as a means of improving air quality before the Beijing Winter Olympics. Manufacturing of fertiliser and urea in Australia was already unsustainable compared to Chinese imports, but the market failure turned when the price of imported fertiliser rose. Today, companies in Queensland and Western Australia are meeting Australia's fertiliser needs, although recent high energy costs are again challenging supply.[63]

## Be effective first

Efficiency was the key driver of modern manufacturing. It was later enhanced to being 'effective and efficient'. However, there's a need to redefine what 'effective and efficient' means under Industry 4.0; it goes beyond measuring inputs and outputs. Industry 4.0 provides the opportunity to drive cross-sector collaboration in achieving regional, national and global outcomes.

We need to think of this as an insurance policy. In the past, the cost of national resilience was high, and the drivers were low. But that's now changed. Governments needs to consider where market forces are insufficient to promote national resilience and be more comfortable proactively intervening rather than being the 'bank of last choice' or the lever that gets pulled in a crisis.

## Innovate government policy

Governments have a key part to play. Some are already on the journey, but more is needed, including:

- rethinking reliance on market forces
- improving our understanding of what's possible
- removing 'real' barriers
- doing what's needed rather than what we've always done
- abandoning innovation hubs (innovation isn't process improvement within departments; public servants are enablers, not innovators)
- pursuing a greater number of opportunities—big and small—over the short, medium and long terms (not every innovation will succeed in changing the world, but every innovation will contribute in some way).

We also need to invest where and when it's needed:

- We need to improve our understanding of venture capital, what it's best for and how to use it. Super funds should be investing in venture capital as a way of accelerating ESG outcomes.
- Australian companies are investing overseas, but Australian innovators have difficulty in attracting funding. These are symptoms of a paradigm that places too much emphasis on reducing risk.

Innovators in northern Australia are leading the way with a commitment to doing new things, not just doing the same things better. They're committed to putting their ideas into practice and by doing so are contributing to Australia's prosperity, security and resilience. We need to acknowledge that this is a journey rather than a destination and address the structural, cultural and economic barriers that limit Australia taking full advantage of Industry 4.0.

# Conclusion

You could be forgiven for thinking that the appetite for innovation in the north is at a level that's disproportionate to its population base. Perhaps it's about not being able to respond to a need by taking a quick trip down the road to pick up supplies. Whatever the reason, innovation in Australia's north is booming.

More than that, northern innovators have a commitment to Australia, its future and the kind of world that they want to create for future generations. This is sovereign capability in action. Thus, they conceptualise, create and deliver by leveraging Industry 4.0 thinking and technology. Technology doesn't drive change, but how they use it does.

But there are barriers and a need for unconventional solutions. Australia has regulatory and standards frameworks and mechanisms that have evolved from traditional Industry 2.0 process thinking and Industry 3.0 manufacturing. There are inherent conflicts within and between sectors that safeguard the *status quo* of outdated and broken supply chains and wasteful manufacturing paradigms.

Australia needs to address these barriers through the following means:

- *Investing.* Support equity investment and fostering anchor clients through fit-for-Industry-4.0 risk frameworks. There's a need to drive innovation investment at scale rather than through 'peppercorn' grants programs.
- *Changing the mindset.* Let go of the process manufacturing thinking and practices of past decades to think and plan for the longer term.
- *Reshaping policy.* Focus on resilience, security and sovereignty when making decisions and policies that influence Australia's economy.
- *Accepting risk.* Be more comfortable with the notion that doing something differently or doing something new is inherently 'risky' when compared to well-used but outdated risk assessments.
- *Being confident.* Have the confidence to invest in homegrown technology and fast-track the take-up of new products and technologies by rethinking service guarantees and after-sales arrangements.
- *Addressing the process maze.* Abandon box-ticking investment approaches and replace them with principles-based guidance that fosters nation-building decisions.

This report highlights how innovators in the north are at the leading edge of the fourth industrial revolution. The challenges they face aren't new, but, if we let them, those challenges will cripple Australia's Industry 4.0 achievements.

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# Acronyms and abbreviations

| | |
|---|---|
| ADF | Australian Defence Force |
| CPI | consumer price index |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation |
| ESG | environmental, social and governance |
| EV | electric vehicle |
| GCHQ | Government Communications Headquarters (UK) |
| IP | intellectual property |
| IT | information technology |
| OECD | Organisation for Economic Co-operation and Development |
| SMEs | small to medium-sized enterprises |
| UN | United Nations |

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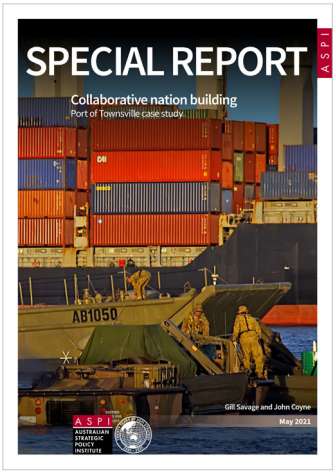



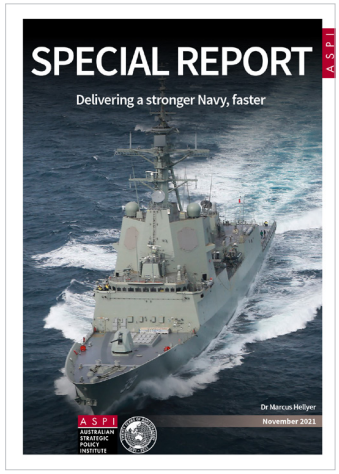

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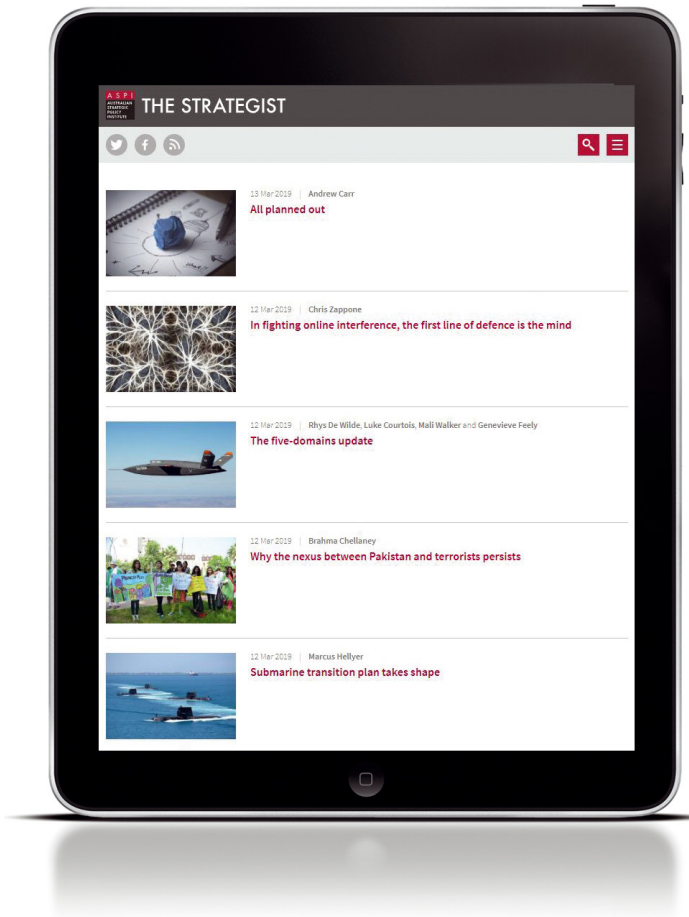


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# Breaking down the barriers to Industry 4.0 in the north

ISSN 2200-6648