BLACK SWAN

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DEFENCE INNOVATION AND THE AUSTRALIAN NATIONAL INTEREST

Authored by Jennifer Jackett

DEFENCE AND SECURITY THROUGH AN INDO-PACIFIC LENS

UWA DEFENCE & SECURITY
THE UNIVERSITY OF WESTERN AUSTRALIA

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Images courtesy of the Department of Defence.

Please direct inquiries to troy.lee-brown@uwa.edu.au

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www.defenceuwa.com.au

UWA Defence and Security Institute
M017, Maths Link Building (Bldg 223)
The University of Western Australia
35 Stirling Highway
Crawley WA 6009
Australia

For all general enquiries:
Email: defenceprogram@uwa.edu.au
Tel: +61 8 6488 4742

Front cover image Avionics Technician, Sergeant Thomas Lane from No. 36 Squadron, utilises the Hololens mixed reality device during maintenance of a C-17A Globemaster III aircraft. Digitally Altered Image.

Inside cover image Lunch-box sized satellites (Cubesats) for the Buccaneer and Biarri space missions.

About the editors

Dr. Troy Lee-Brown

The Black Swan Strategy Papers are edited by Dr. Troy Lee-Brown, Research Fellow at the UWA Defence and Security Institute.

A researcher in regional security, maritime security and international relations with a focus on the Indo-Pacific, he is currently the Project Manager for 'Blue Security', a joint Defence and Security Institute-La Trobe Asia-Griffith Asia Institute-UNSW Canberra project which focuses on issues of maritime security in the Indo-Pacific.

Troy has authored several journal papers with a focus on security issues in the Indo-Pacific, regionalism and maritime security. His research interests include the Indo-Pacific, India, Japan, Indian Ocean Region and maritime security.

(E) troy.lee-brown@uwa.edu.au

Fiona Considine

Fiona is the inaugural Business Manager for the UWA Defence and Security Institute. As Business Manager, she is responsible for the high-level planning, coordination and execution of all DSI programs, stakeholder engagement and outreach activities. She has over 20 years' experience in Event and Program Management which has provided the platform and expertise for the brand development, engagement and profile building for DSI. Fiona is the Creative Director of the Black Swan Strategy Paper and oversees its design and content.

(E) defenceprogram@uwa.edu.au

About the author

Jennifer Jackett

Jennifer Jackett is a Non-Resident Fellow in the Foreign Policy and Defence Program at the United States Studies Centre. She is on leave from the Australian Government while pursuing a PhD as a Sir Roland Wilson Scholar at the National Security College at the Australian National University. Her research examines the role of allies of the United States in US-China competition for leadership of advanced technologies.

Jennifer has experience advising government on issues including critical infrastructure security, countering foreign interference, counter terrorism, and international defence engagement. Jennifer holds a Master of National Security Policy from the Australian National University and a Bachelor of Liberal Studies (First Class Honours and University Medal) from Sydney University.

(E) jennifer.jackett@anu.edu.au

Twitter: @jen_jackett

About the Black Swan Strategy Papers

The *Black Swan Strategy Papers* are the flagship publication of the UWA Defence and Security Institute (DSI). They represent the intersection between Western Australia and strategic studies – both of which are famous for their black swans. The series aims to provide high-quality analysis and strategic insights into the Indo-Pacific region through a defence and security lens, with the hope of reducing the number of 'black swan' events with which Australian strategy and Indo-Pacific security has to contend. Each of the Black Swan Strategy Papers are generally between 5,000 and 15,000 words and are written for a policy-oriented audience. The Black Swan Strategy Papers are commission works by the UWA DSI by invitation only.
Any comments or suggestions for the series can be directed to the editor.

Saildrone uncrewed surface vehicles operate in the waters of Jervis Bay during Ex Autonomous Warrior 22 at HMAS Creswell, ACT.

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↑ Australian Army soldier Corporal Meg Reeves (right) uses a Ghost Robotics quadruped robot for a reconnaissance task at Mount Pleasant, Canberra.

Executive summary

Rapid technological advances are transforming the nature of political, economic, and military power in the Indo-Pacific region. Leadership of development and deployment of advanced technologies is a defining arena of strategic rivalry between China and the United States (US), which each country sees as vital to their security and prosperity.

Advanced capabilities arising from developments in areas like artificial intelligence, quantum computing and hypersonics are a critical component of the Australian Government's strategy to deter conflict and if necessary, respond to hostile states in the Indo-Pacific.

Australia's strategic circumstances necessitate speed and agility in the development and deployment of advanced capabilities that could improve the ability of the Australian Defence Force (ADF) to fight and win. But challenges in Australia's defence innovation ecosystem risk leaving the military and country ill prepared.

The Australian Government is taking steps in the right direction. The Advanced Strategic Capabilities Accelerator (ASCA) is to be established in July 2023, following the Defence Strategic Review (DSR). The aim is for ASCA to fast-track the translation of nationally significant science and technology research into game changing military applications.

This paper argues that ASCA is only a partial solution to the challenges facing defence innovation. Existing institutional structures and culture shaping defence innovation urgently require disruption and reform. This must be guided by clear strategy, closer partnerships with industry and academia, collaboration with international partners and supported by increased funding. Only transformational change will yield transformational results.

Policy recommendations

1. The Australian Government should develop a Defence Innovation Strategy as part of the National Defence Strategy process in 2024, including a review of best-practice defence innovation among international partners.
2. The Department of Defence (Defence) should institutionalise closer collaboration on defence innovation with non-government partners, including a secondment program for industry and academia to fill leadership positions in ASCA.
3. The Australian Government should continue to address bureaucratic barriers to defence innovation, including by moving ASCA outside the Defence portfolio following its first 18 months of operation.
4. Defence should strengthen international scientific collaboration, including by using ASCA to pursue joint technology acceleration with the US and the United Kingdom (UK) as part of AUKUS and with other close partners like Japan.

↑ The Australian Government announces its response to the Defence Strategic Review on 24 April 2023

Introduction

Following Russia's illegal invasion of Ukraine in February 2022, the Ukrainian military has continued to demonstrate the ability to defend itself against a much better-resourced adversary.

One key factor has been innovation. Ukrainian soldiers have proven adept at using applications of commercial technologies to support military effects. This includes 'Uber for artillery' and equipping drones with grenades, right through to the use of SpaceX Starlink satellites for communications. Rapid and disruptive approaches to innovation in Ukraine can be instructive for countries like Australia seeking to quickly bolster their military capability.

While Australia is not facing an immediate existential threat like Ukraine, it does have an urgent need to prepare for a deterioration in the security environment in the Indo-Pacific. Strategic competition between the US and China continues to intensify. The 2023 DSR made clear that Australia has lost its warning time of 10 years for major conflict. Australia needs to quickly enhance its military preparedness for a possible contingency within a five-year window.

A technology edge is critical to Australia's defence strategy of deterrence by denial. The ADF requires lethal asymmetric capabilities across the domains of air, land, maritime, space and cyber that can increase the cost of aggression by adversaries against Australia and its interests. Ideally, Australia's capabilities, combined with those of its partners like the US, could alter the calculus of hostile states to use coercive or aggressive tactics in pursuit of their interests. Should deterrence fail, such capabilities must be able to be deployed to hold adversary forces at risk, and if needed, to support the ADF to fight and win.

Australia is taking steps to improve innovation in support of its defence strategy. In April 2023, the Australian Government announced it would establish ASCA. The aim is for ASCA to fast-track the translation of nationally significant science and technology research into game changing military applications. But technology acceleration is only a partial solution to the defence innovation challenges Australia faces. Without a refreshed defence innovation strategy, there is a risk the military and country may be ill prepared. More disruptive and ambitious reforms are needed to hasten defence technology development, foster closer partnerships with industry and academia, and strengthen international collaboration. Australia cannot pursue similar approaches to defence innovation and expect a different result.

This paper proceeds in four parts. Chapter 1 details the geopolitical context and strategic drivers shaping the role of innovation in defence strategy and the Australian national interest. Chapter 2 outlines what good defence innovation looks like. Chapter 3 explains Australia's defence innovation context, its reform agenda, and the need for further changes. Chapter 4 outlines further steps Australia could take to improve its approach to defence innovation.

↑ The Boeing Australia 'Ghost Bat' uncrewed aircraft conducts its first flight at Woomera Range Complex, South Australia, in 2021.

CHAPTER 1
Geopolitics of science, technology and innovation

Technological disruption in the 21st century

Science, technology, and innovation have always played a role in political, military, and economic power and the relative global influence of nation states. However, we are currently in a period of upheaval. Rapid evolutions in technology are underway in the civilian and military domains, including the diffusion of artificial intelligence-enabled systems like OpenAI's ChatGPT. Strategic competition between the US and China is intensifying, with technology as a key driver.

Technology is changing the character of inter-state competition and conflict. The absence of war in the Indo-Pacific should not be mistaken for a period of peace. Hostile acts below the threshold of war, like economic coercion and political interference, are proliferating. Vastly increased digital connectivity and new applications, including in areas like social media, are enabling risks like malicious cyber activity, foreign interference, and disinformation.

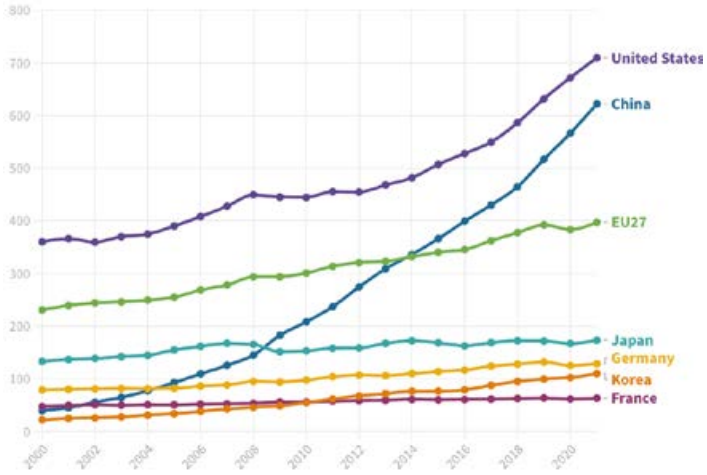
At a time when technological leadership is paramount to how states exercise power, the US and likeminded states are losing their edge to competitors like China. The Australian Strategic Policy Institute's (ASPI) Critical Technology Tracker highlights the extent of these shifts. In high-impact research, China leads the world in 37 out of 44 critical technologies. This includes fields ranging from defence and space to biotechnology and artificial intelligence.[1]

China's technological rise should not be surprising. Strengthening its high-tech sector and increasing its technological self-reliance has been a priority of the Chinese Communist Party for years. Alongside strategic plans like Made in China 2025, billions of dollars have been provided in industry assistance.

China is thought to spend twice as much as the US on industrial policy. Chinese industrial spending reached at least 1.73% of GDP in 2019, around US$248 billion. This surpassed China's defence spending that year, which was around US$240 billion.[2] China's investment in areas like research and development (R&D) has outpaced spending by advanced economies like Japan, Germany, South Korea and France (see figure over page – Gross domestic expenditure on R&D, selected economies, 2000-2021).[3]

A key concern for Washington and likeminded capitals like Canberra is the way in which China's technological advancement is supporting its military

Figure 1: Gross domestic expenditure on R&D, selected economies, 2000-2021.
USD billions in constant PPP prices.



Source: OECD R&D statistics, February 2023

modernisation and power. The ASPI Critical Technology Tracker found that China leads high-impact research for 19 of 23 critical technologies that are relevant to the AUKUS strategic partnership between Australia, the US and the UK. Of note, China is judged to have a 'commanding lead' in hypersonics, electronic warfare, and undersea capabilities.[4] Through an approach of 'civil-military fusion', the Chinese Government has sought to quickly translate scientific developments into capabilities that can challenge US military dominance.

Steps by US and likeminded states to bolster technological competitiveness

China's technological rise has been a catalyst for policy change in Washington. The Biden administration, building on foundations laid by the Trump administration, has sought to reinvigorate American technological leadership. The US has pursued a three-pronged strategy of 'protect, promote, partner'. American strategy seeks to maintain America's technological edge by protecting sensitive technologies, investing in the long-term foundations of American competitiveness, and bolstering the technological resilience of other countries.

De-risking supply chains of Chinese vendors in 5G telecommunications networks was an early focus of Washington's efforts. Huawei and ZTE were excluded from American 5G infrastructure on national security grounds. This was followed by moves to strengthen scientific prowess and production capacity for key inputs like semiconductor chips. The *CHIPS and Science Act of 2022* directs US$200 billion for scientific R&D and commercialisation and over US$52 billion for semiconductor manufacturing. Most recently, the US has restricted advanced chip exports to China to constrain Chinese military advances.

American strategy has had consequences for traditionally important areas of US-China cooperation. Enhanced scrutiny of academic research, for example, has likely contributed to a sharp decline in US-China collaboration on joint scientific publications, off the back of otherwise steady growth (see figure below – Bilateral collaboration intensity trends in scientific publications).

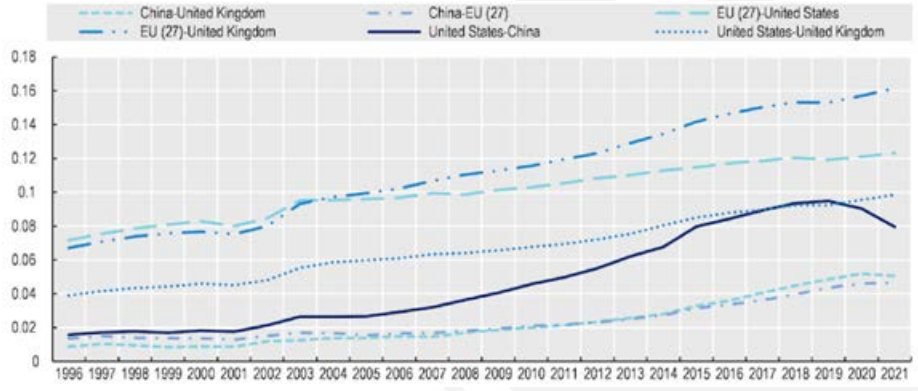
Renewed focus on technological competitiveness has not been limited to Washington. European states have broadly shared US concerns regarding a relative decline in their technological capabilities vis-à-vis' China. The *European Chips Act*, for example, aims to strengthen Europe's competitiveness in semiconductor technology. Currently, the European Union only has a 10% share of the global chips market.[5]

National approaches by Washington and likeminded capitals have been complemented by a rapidly advancing techno-diplomacy agenda. Cooperation on critical technologies has become a central pillar of bilateral talks and groupings including the Quad between the US, Japan, India and Australia; AUKUS; the G7; and the EU-US Trade and Technology Council.

Resilience is now being prioritised over efficiency, with the risks of protectionism and 'techno-nationalism' rising. Many leading economies have sought to move supply chains for critical goods like chips or inputs like critical minerals back home (on shoring), closer to home (nearshoring), or to trusted partner economies (friend shoring).

This collision of geopolitics with technology policy is leading to a period of transition in the international economy. The US and its allies are actively using tools of economic statecraft like investment screening and export controls to advance their interests. We are now moving into an era characterised by a more managed form of openness, and in some cases, what might be termed as de-globalisation.

Figure 2: Bilateral collaboration intensity trends in scientific publications, 1996-2021.



Source: OECD Science, Technology and Innovation Outlook 2023.

Technology and defence innovation

Shifts in the balance of technological leadership have drawn particularly sharp responses in the military domain. The US and its allies are pursuing major initiatives to maintain – and in some instances regain – a military technological edge. The AUKUS strategic partnership between the US, Australia and the UK is the most obvious example.

How the US and its allies are approaching defence innovation is different from strategic technological competition between the US and the Soviet Union during the Cold War. In that era, the US government and its prime contractors played a leading role in defence innovation. Barriers for non-government players were high.[6]

Private industry now drives innovation, including for dual-use technologies (those that have potential civilian and military applications). National governments are investing less in R&D than industry and universities. Chinese telecommunications company Huawei spent almost as much on R&D in 2021 (around A$31.9 billion) as gross expenditure in Australia nationally in 2019-20 (A$35.6 billion). Industry is also able to develop technologies much faster than governments. This includes for drones, satellites, and applications of artificial intelligence.

The critical role of industry and academia in innovation means that governments need to look outside themselves to secure a military edge. The US and its allies are actively seeking new and improved ways to harness and co-develop technology with non-government partners.

New organisations intended to accelerate civil-military scientific cooperation and dual-use technology development have proliferated. There are many examples to point to.

- **The United States** – NavalIX, founded in 2019; the Defence Innovation Unit, formed in 2015; and the Strategic Capabilities Office, created in 2012. This is in addition to longstanding and well-known organisations like the Defense Advanced Research Projects Agency.
- **The United Kingdom** – the Advanced Research and Invention Agency (ARIA), established in January 2023; the Defence BattleLab, opened in 2022; and the Defence Innovation Initiative, launched in 2016 supported by the Defence and Security Accelerator and the Defence Innovation Fund.
- **Germany** – the Agency for Innovation in Cyber Security, established in 2020; and the Federal Agency for Disruptive Innovation (known as SPRIND) created in 2019.
- **Japan** – the Science and Technology Agency's Moonshot Research and Development program, launched in 2019.
- **NATO** – the Defence Innovation Accelerator for the North Atlantic (DIANA), created in 2022.

It is in this context that Australia is also pursuing defence innovation reform through the establishment of ASCA. Like many of the organisations listed above, ASCA aims to translate research into game-changing military capability.

The pursuit of better defence innovation is not unique to likeminded democracies. China has big ambitions to reform its defence science, technology and innovation ecosystem to address inefficiencies.[7] The Chinese Government launched its own version of DARPA in 2017, the Military Science Research Steering Committee.[8]

What is important, however, is not just that there has been a step-up in focus on defence innovation globally. What matters is whether the approach being pursued will result in improvements to military capability. That requires an understanding of what makes good innovation, to which the next chapter turns.

↑ On 13 March 2023, Australian Prime Minister the Hon Anthony Albanese MP, President of the United States Joseph R. Biden and United Kingdom Prime Minister Rishi Sunak announced the Optimal Pathway for Australia to acquire conventionally-armed, nuclear-powered submarines.

CHAPTER 2
What makes good innovation?

Defining innovation

Innovation has many different definitions. At its most basic level, it can be defined as the 'creation and application of new products, services and processes. It encompasses new technology as well as new ways of doing things'.[9] Innovation is about 'making good ideas stick'.[10]

It is important to distinguish between invention (discovery) and innovation (application). It is not sufficient to just be at the frontier of research, as China has shown in relation to critical technologies. Innovation comes down to how that research is translated for practical effect.

In the defence context, innovation is about providing the military with better capability, so they are better able to deter conflict, and if needed, fight and win wars. In other words, defence innovation can be defined as the 'transformation of ideas and knowledge into new or improved products, processes and services for military and dual-use applications'.[11] Defence innovation implies that there are changes – sometimes costly – that are worth making to the military and how it operates.

Defence innovation is not only about defence. The defence innovation ecosystem is a subset of the national innovation ecosystem. It encompasses 'organisations and activities associated with the defence and dual-use civil-military science, technology and industrial base'.[12] The state of defence innovation is therefore contingent on the broader state of technological advancement in the economy and society.[13]

Innovation is hard to measure. There are many innovation indexes. A common proxy for innovation is the scale of venture capital (financing for startups and small businesses). An MIT study from 2019 found innovation was most successful in concentrated, geographically bounded hubs or ecosystems where there is the right mix of inputs, talent and incentives.[14] Even in advanced innovation ecosystems like the US, innovation is largely concentrated in places like Silicon Valley, New York and Boston.

Just like broader national innovation ecosystems, defence innovation ecosystems vary in shape and size globally, as shown in the following examples.

- The US has a technologically sophisticated and industrially mature innovation ecosystem. It includes a market-based governance regime, incentives for risk-taking, intellectual property protection, and a strong research base in industry and universities that drives high levels of original innovation.[15]
- Israel's defence innovation ecosystem is characterised by non-hierarchical norms and the prevalence of assertive and risk-taking behaviour. This enables a 'free-wheeling disruptive environment'.[16]
- Singapore's defence innovation environment has the opposite characteristics to Israel, whereby a hierarchical social order and risk-averse culture results in incremental innovation.[17]
- China displays qualities unique to a rapidly catching up defence innovation ecosystem. Strong government leadership and high resource allocation drives the system, which still relies on access to foreign technology and knowledge to support innovation outcomes.[18]

What good defence innovation looks like, and how innovation unfolds, is therefore highly dependent on the context. There is no 'one size fits all' approach.

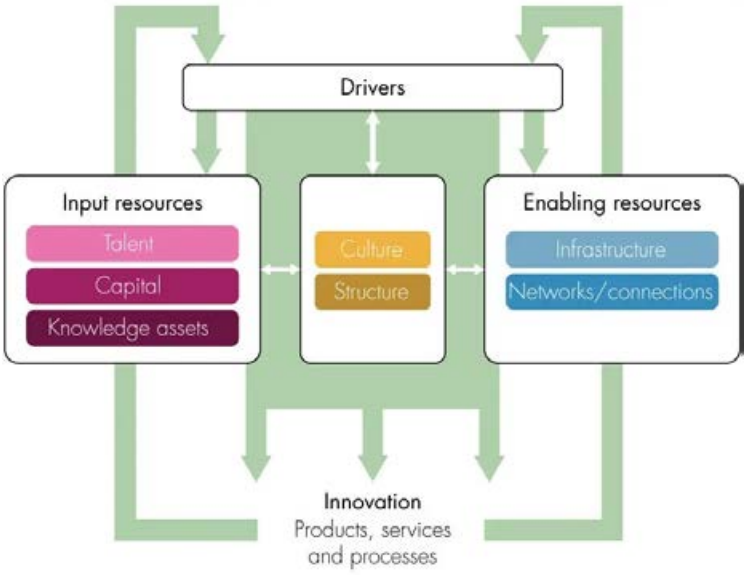
There are very few states with capacity to build and sustain cutting-edge military capabilities. The US, China, UK, Russia, South Korea and France are chief among them.

Policy objectives of the government play an important role in shaping a country's defence innovation ecosystem. Countries generally face tensions and even trade-offs between different goals. Policies aimed at assisting and strengthening their domestic defence industries could conflict with policies intended to improve the innovation ecosystem and international competitiveness.[19]

Conceptualising the defence innovation process

Despite the variety of approaches to defence innovation, and different national policy objectives, there are some consistent features of a defence innovation process. As part of a major study of defence innovation, research organisation RAND corporation developed a useful model for understanding how different parts of a defence innovation ecosystem interact to produce new products, services and processes (see graphic below – RAND innovation framework).[20]

Figure 3: RAND innovation framework



(Source: Freeman et al, 2015, Innovation Models: Enabling new defence solutions and enhanced benefits from science and technology, reprinted with permission)

RAND identifies four critical components of the defence innovation process:

1. The drivers, like the external threat environment and regulations like intellectual property regimes
2. The input resources, such as human talent, capital, and knowledge assets like technology transfer
3. The enabling resources, including research infrastructure and networks and connections between different stakeholders across the ecosystem
4. The shaping factors like culture and structures.

Such a process is clearly complex, and there are many interdependencies and feedback loops between different parts of the system.

Some specific factors have been found to matter more for innovation in new and emerging technologies, like artificial intelligence. This includes a technological environment that supports revolutionary breakthroughs; strong networks connecting researchers and entrepreneurs; and, most importantly, institutional and cultural factors that embrace risk (like US DARPA's 'high risk, high reward' approach), and experimentation and collaboration between defence and industry.[21]

A distinction can be made between 'hard' and 'soft' factors. Hard factors include inputs and infrastructure like government research labs and human capital. Soft factors include political and institutional structures that shape non-technical and process-related activity.[22] The 'soft' factors, so critical to innovation, are the most challenging to get right. But they are also where the biggest opportunities are for disruption.

Improving inclusion and diversity in defence organisations, for example, could be game-changing for defence innovation. Inclusive cultures are six times more likely to be innovative, according to a recent report by the Centre for Strategic and International Studies.[23] A report by Citigroup in 2020 estimated that in the US, including more women and Black Americans at earlier stages of the innovation process could increase US GDP by around US$640 billion.[24]

Some of the biggest opportunities for disruption relate to how defence organisations partner with industry and academia. In a major study of the UK's approach to defence innovation in 2015, RAND identified four important areas for change – most of which were 'soft' factors. The UK's Ministry of Defence needed to improve its culture to recognise and absorb innovation; better communicate defence needs to external actors to encourage and support collaboration; strengthen external partnerships to better utilise knowledge, talent and capital; and create new spaces for innovation with external partners.[25]

Putting innovation into practice

Improving the process of innovation, however, is in and of itself insufficient. The benchmark for success is not just that innovation takes place.

Firstly, it matters how quickly innovation occurs to support the acquisition of military capability. One model of defence innovation that can help drive timely results is 'open innovation'. Open innovation 'aims to detect, stimulate and capture innovations from the civilian world and to integrate them into the military in short cycle'.[26] It involves repurposing 'high technical readiness level' products and services to address software, hardware, people or process problems.

Other sectors, like the pharmaceutical sector, use a similar model to re-purpose existing drugs for new therapeutic uses.[27] There are also more recent examples in a defence context that demonstrate the advantages of an open innovation approach. Notably, Ukraine's military has quickly deployed commercial technologies for military effects.

Secondly, it matters how well a new product, service or process is integrated into the defence organisation to effect strategy. This includes how capabilities are reflected in warfighting concepts and doctrine to deliver a desired effect.

Acquiring a new capability like Australia's planned acquisition of the SSN-AUKUS nuclear-powered submarine, for instance, requires many changes to defence strategy and planning. There is a risk that policymakers focus too heavily on the technology solution, or the military hardware like jets and bombs, as a silver bullet for defence strategy. In other words, 'technological fetishism'.[28]

The 'game changing' impact of new capabilities arising from advances in areas like quantum technologies can especially be subject to 'hype'. That is not to underestimate the real potential of quantum technologies, particularly in relation to encryption and decryption. But, the disruptive impact of such technologies, and the timeframe in which disruption occurs, can sometimes be overstated.

Many other factors come into play for innovation outcomes to successfully achieve a particular effect. These include the institutions, strategies and policies, and leadership that govern defence organisations.[29]

The role of institutional and cultural factors in influencing how new technologies are absorbed was evident in a study of attitudes towards artificial intelligence in the Australian Army published in 2023. Rather than artificial intelligence resulting in revolutionary upheaval for the military, interviews with officers suggested that military innovation would occur as a constant evolutionary process. That gradual evolution would be the result of collective assessment, debate, and consensus building around how to integrate new technologies.[30]

There is a reason why defence organisations are conservative and change can be slow. Innovation can be an 'unnatural act for organisations that are, by their very nature, meant to routinize rather than innovate'.[31] Innovation can carry risks. A historical study from 2022 highlighted the potential 'perils' of innovation. British innovations in armour resulted in armoured brigades being deployed in North Africa during World War Two without supporting arms support. Cannibalising existing capabilities before an innovation was shown to improve military performance was costly.[32] While defence innovation is generally considered desirable, it is important to also understand what may be lost in the innovation process.

↑ Australian Army soldier, Lance Bombardier Liam Wilson, from 20th Regiment, Royal Australian Artillery removes the Integrator Tactical Uncrewed Aerial System from the skyhook at Shoalwater Bay, Rockhampton, Queensland. (Source: Department of Defence 2023).

CHAPTER 3
Australia's journey to improve defence innovation

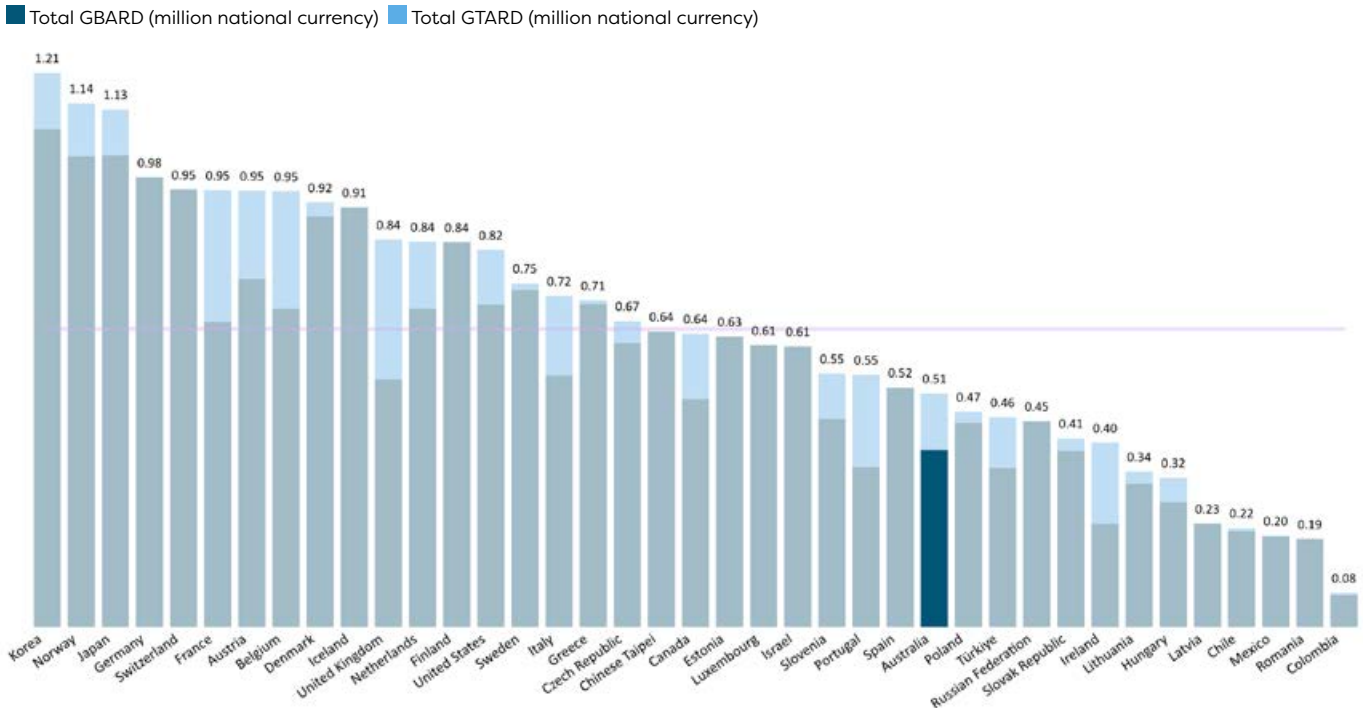
Challenges and opportunities in Australia's defence innovation ecosystem

Australia has a growing defence innovation ecosystem. International defence primes (like BAE Systems, Boeing, and Thales) have offices in Australia. There are many small and medium-sized enterprises. The country has world-leading, publicly funded research institutions like Defence Science and Technology Group (DST) and the CSIRO. Australia also has world-class research infrastructure like the Australian Synchrotron and the Square Kilometre Array Observatory.

There are positive examples of collaboration between Defence, industry, and academia on various capability projects. This includes the Armidale-class patrol boat, LAND 17, the self-propelled howitzer, the integrated Battlefield Telecommunications Network (Project Currawong), and the Boeing Loyal Wingman or 'Ghost Bat' uncrewed aircraft.[33]

There are also some emerging success stories. Melbourne-based Ascent Vision Technologies Australia, is helping to deliver the Army's STRIX Tactical Uncrewed Aerial System (UAS) (Land 129 Phase 3). A prototype was launched at the 2023 Avalon Airshow. The company developed the sensor gimbal system for the tactical UAS, which provides advanced optical, infrared scanning and laser targeting capabilities (pictured).[34]

Figure 4: Investment of government budget allocations for R&D (GBARD) and government tax relief for R&D expenditures (GTARD) as a percentage of GDP by country



Source: 'Science, research and innovation budget tables 2022-23', Australian Department of Industry, Science and Resources.

The 'Ghost Shark' autonomous robotic undersea warfare vehicle is being designed and manufactured by Anduril Australia. Defence scientists, Navy personnel and Anduril robotics specialists are working together to produce three prototypes. The project received funding from the Next Generation Technologies Fund (to be absorbed by ASCA) and is reportedly running ahead of schedule.

Successes should be celebrated and also serve as examples to follow. However, there remain critical challenges in Australia's defence innovation ecosystem. There are headline issues related to the management and funding of defence innovation programs; commercialisation of defence-funded research and innovation; and contractual arrangements to support rapid acquisition and transition from concept to capability.[35]

Specific defence innovation initiatives like the Defence Innovation Hub have also not performed well. Of A$441 million invested in defence innovation projects in the past five years, around 7% were close to acquisition by the ADF and less than 5% resulted in export success.[36]

There are several reasons for these challenges. An assessment of Australia's defence industry by the Massachusetts Institute of Technology in 2019 found that Australian policies have placed too much emphasis on industry and job creation at the expense of driving genuine innovation or meeting new capability demands. Defence has also not been good at articulating requirements for capability. Moreover, defence innovation has focused too much on supporting industry (small and medium enterprises through to prime contractors), with limited collaboration with universities.[37]

Challenges to a key input into the innovation process – capital – have further diminished Australia's capacity for disruptive innovation.[38] The Australian Department of Defence spends about 3% of its budget on defence innovation. By comparison, the US spends around 13% and the UK spends around 7%.[39] Defence experts have long called for an Australian DARPA, in part to boost funding for early-stage R&D.[40]

Despite the relatively low levels of Defence spending on defence innovation, DST is the second-largest publicly funded research organisation in Australia after the CSIRO. Funding for DST is estimated to comprise about 4% of total government investment in R&D in 2022-23 at A$472.7 million. However, funding has remained at similar levels since 2010 and there have been limited increases in Defence investment in R&D over the past decade compared to other portfolios.[41]

More generally, Australian Government investment in R&D is relatively low compared to OECD partners (graph above).[42] Australia's combined government investment in R&D and tax relief for R&D spending is about 0.5% of GDP.

Beyond government investment, Australia has only seen modest increases in R&D nationally in the past decade across all sectors.[43] In 2019, Australia spent about 1.8% of GDP on R&D, compared with the OECD average of 2.5%.[44] Sustaining higher levels of R&D is necessary to support technology-driven economic transformations, like the internet revolution of the 1990s.

Australian defence innovation reforms

Successive governments in Australia have sought to reform defence innovation practices and address institutional, bureaucratic, cultural and funding challenges. This has been driven by some key reviews.

In 2015, David Peever led a landmark review of the defence organisation, the First Principles Review. The review recommended closer partnerships between DST, research institutions and industry, including outsourcing elements of its research, better alignment between Defence research priorities and war fighter requirements, and working with allies to promote innovation.

A few years later, challenges remained. In 2018, ASPI and the Australian Industry Group conducted a survey of companies and higher education and research entities regarding R&D support for defence, intelligence and home affairs-related work. The survey found concerns with a lack of capability policy and priority development, which made it difficult to engage on future requirements.[45]

In 2021, the former Coalition government commissioned the Defence Innovation Review (DIR). This review was also led by Peever. The review findings were not publicly released. However, a redacted version was published as part of a *Freedom of Information Act 1982* request in early 2023.

The DIR found that Australia's defence innovation ecosystem 'needs a much stronger sense of urgency' to contend with 'three rapidly evolving, disruptive trends: a more complex and rapidly changing international climate; the changing character of warfare; and rapidly emerging new technologies'. Importantly, the DIR acknowledged that 'innovation which can benefit Defence tends to come from outside of Defence – largely from industry'.[46]

The publicly available DIR findings are broadly consistent with the unclassified Defence Strategic Review, released in April 2023. The DSR assessed that 'Defence's current approach to capability acquisition is not fit for purpose. The system needs to abandon its pursuit of the perfect solution or process and focus on delivering timely and relevant capability'.[47] Speed is key, especially in dangerous strategic circumstances where the ADF needs to be prepared for a potential military contingency within a five-year horizon.

Following the DSR, the 2023-24 Budget identified innovation as one of six priority areas for Defence. Defence must focus on 'lifting our capacity to rapidly translate disruptive new technologies into ADF capability, in close partnership with Australian industry'.[48] The Advanced Strategic Capabilities Accelerator (ASCA) is the key initiative being pursued in support of this priority.

Reforming defence innovation through ASCA – what we know

On 28 April 2023, the Albanese government announced that it would establish ASCA by 1 July 2023. ASCA's aim is to improve defence innovation, the speed of capability acquisition, and collaboration between government and industry. The end goal is to 'ensure game-changing ideas are developed into capabilities that give the ADF an asymmetric advantage'.[49] ASCA's initial priorities include hypersonics, directed energy, trusted autonomy, quantum technology, information warfare and long-range fires.

Australia's Defence Industry Minister Pat Conroy has acknowledged that "the old defence innovation model effectively sprayed the money far and wide…[and] there wasn't an acquisition program that would then develop that technology into service". ASCA is intended to be more focused. The government wants ASCA to focus on attaining 'minimum viable capability'. ASCA is also intended to work faster than its predecessors and accelerate technology development earlier in the innovation cycle. Minister Conroy's goal is that this will deliver capabilities that could be "used by our troops in theatre in five or seven years' time", supported by an acquisition program that supports commercialisation in Australia rather than overseas.[50]

ASCA will replace existing defence innovation functions, including the Next Generation Technologies Fund (focused on early-stage research) and the Defence Innovation Hub (focused on later-stage technologies). ASCA will also incorporate activities undertaken by the Capability Accelerator Fund and the Rapid Prototyping Initiative.[51]

Like its predecessors, ASCA will be a part of the Defence portfolio within the DST. Whether this is the best approach is debatable. The independent view of the DSR authors was that ASCA would benefit from being 'an unencumbered entity outside of Defence'.[52] Establishing ASCA within Defence may allow it to be stood up quickly. ASCA will also benefit from close oversight by senior Defence leaders, the Vice Chief of the Defence Force, the Chief Defence Scientist and the Deputy Secretary, Capability Acquisition and Sustainment Group. However, keeping ASCA within DST and Defence means it will be subject to the same bureaucracy and processes that have historically hindered the speed and agility of defence innovation programs.

The government has committed A$3.4 billion for ASCA in the coming decade. This represents a net increase in spending on defence innovation of A$557 million, or around A$56 million annually. In the recent federal Budget, A$900 million was allocated in the forward estimates (next four years) for defence innovation, including A$748.4 million for ASCA and the remainder supporting AUKUS Pillar 2. About A$600 million comes from existing projects, and A$300 million is new money that needs to be offset by Defence.[53]

The increases in spending should be kept in perspective. Australian defence innovation funding remains modest compared to US Department of Defense (DoD). The US DoD spends more than US$120 billion annually on Research, Development, Testing and Evaluation, including US$15 billion for early-stage science and technology.[54]

Nevertheless, any additional investment in defence innovation is much needed and worthwhile. It could also result in positive spill-overs for the economy and society. Universities Australia estimates that every A$1 invested in research adds A$5 to the Australian economy.[55] For CSIRO, every A$1 invested returns A$8.40 to the Australian people.[56]

↑ Announcement of ASCA in Sydney with Deputy Prime Minister and Minister for Defence, the Hon Richard Marles MP, and the Minister for Defence Industry, Minister for International Development and the Pacific, the Hon Pat Conroy MP with Chief Defence Scientist, Defence Science and Technology Group, Professor Tanya Monro.

CHAPTER 4
The case for more ambitious defence innovation reforms

Refreshing the strategy around defence innovation

ASCA is an important step in the right direction, but it will not be a panacea for all of Australia's defence innovation challenges. It may go some way to addressing issues of technology acceleration. However, broader institutional and cultural issues are likely to remain, including risk aversion, the specificity of priorities and requirements, and the need to deepen defence-industry-academia collaboration. A more ambitious defence innovation reform agenda is needed.

Only transformational change will yield transformational results. ASCA provides the catalyst for a broader conversation around what is needed to improve the defence innovation ecosystem. A major study of Australian innovation system stakeholders in 2022 found that Australia needed a clearer national ambition regarding innovation.[57] Australia needs clear aspirations for defence innovation. What would the best version of Australia's defence innovation ecosystem look like, what purposes would it serve, and how do we get there?

In 2015, research organisation RAND corporation helped articulate a radical and future-focused vision of defence innovation for the UK Ministry of Defence (MOD). The overarching aspiration was that 'the scientific and technical staffs of the MOD have become national exemplars of the process of fielding new products, services and processes that provide excellent military capability, even though the resources available are fewer than desired'.[58] Australia's aspirations are likely to be similar.

Australia's vision for defence innovation should be used to guide a refreshed strategy around defence innovation. The last strategy, *More, together: Defence Science and Technology Strategy 2030*, was released in 2020. This was before the Defence Strategic Update, AUKUS, the DIR and the DSR, as well as the global fallout of the COVID-19 pandemic, Russia's invasion of Ukraine, and intensifying strategic rivalry in the Indo-Pacific.

The National Defence Strategy in 2024, an outcome of the DSR, presents an opportunity to develop an accompanying new Defence Innovation Strategy. This should articulate defence innovation priorities with a clear line to policies, programs, and funding.[59] The strategy should help signal defence requirements to industry and academia in a more detailed way than the existing Science, Technology and Research (STaR) Shots.[60]

A refreshed strategy should be informed by a detailed understanding of the current state of the defence innovation ecosystem. Who is involved, how does it operate, and what are the points of disconnect inhibiting better outcomes? How does Australia uplift that system to get closer to the vision?

One of the most important drivers of a refreshed strategy is the increasingly dangerous Indo-Pacific security environment. Getting capability quickly into the hands of the war fighter must be the strategy's north star.

New and creative approaches to innovation – like an open innovation model – could support Defence to capitalise on private sector innovation and quickly re-purpose commercial technology for military ends. How to adopt such a model should be considered through the strategy's development, including the innovation lessons learned from Ukraine's response to Russia's invasion.

To be sure, an open innovation model will not meet all Defence requirements. For instance, such a model would not deliver big platforms that take decades to build and require complex supply chains to sustain them. As some defence analysts have put it, 'there are no GoogleX aircraft carriers or Apple iBombers'.[61]

But an open innovation model could support the acquisition of capabilities that might provide an asymmetric advantage. For example, swarms of unmanned aerial systems to support surveillance activities. Such capabilities would also be cheaper than those delivered by current defence innovation approaches.

Defence should also look to its international partners to help inform a refreshed strategy. There are many lessons Australia can learn about best practice, and failures, in the approach of close and trusted partners like the US, UK and Japan.

There will be tensions in a new defence innovation strategy, which the government will need to successfully overcome. Policies aimed at supporting Australia's defence industry and increased self-reliance may be at odds with broader government policies that seek to improve innovation and the competitiveness of Australian companies.

A refreshed defence innovation strategy will not solve broader challenges in the national innovation ecosystem. Other government portfolios have a key role to play to address issues like R&D funding, procurement rules, low levels of manufacturing self-sufficiency (the lowest in the OECD), the skills pipeline and tax incentives for R&D, and ensuring the intellectual property regime encourages innovation.

Setting ASCA up for success

In the shorter term, Defence will be keenly focused on establishing ASCA. Although ASCA would need to be reflected in any refreshed defence innovation strategy, there are many steps that Defence can take outside that process to help set up ASCA for success.

ASCA's purpose will need to be focused. In the first 18 months of its establishment, the organisation needs the opportunity to prove its operating concept and adapt its model. That means having clear priorities within each of the missions and empowering staff to operate quickly and flexibly without too much stifling government bureaucracy. ASCA's measure of success will be how fast it gets additional capability into the hands of the war fighter.

Government's commitment to support ASCA to take "a more flexible and agile approach to procurement"[62] will be an important enabler for the speed with which ASCA can operate. ASCA could learn from existing approaches like Defence's 'Project Greyfin' that supports rapid investment in new technologies for Australia's Special Forces.[63]

Talent will also be a key input impacting how ASCA supports the defence innovation process. People will be vital to driving ASCA's purpose, culture and ultimately, its success. ASCA's leadership will need to embrace risk and adopt the 'innovation mindset' described by the Deputy Prime Minister and Minister for Defence, the Hon Richard Marles MP, as "one where we are not afraid to fail fast, learn, and adapt".[64]

ASCA mission managers need to find the right mix of skills, including people with industry experience, along with legal, financial, and human resources experts to support them in their roles. ASCA also needs to involve military end-users who can sensibly guide technology development. The current competition for talent is fierce. ASCA needs the right incentives to attract and retain a highly sought after workforce. These might be remuneration, recognition, travel or research funding – in addition to the opportunity to advance the national interest.

Industry and academia are critical partners for ASCA. Defence could seek to institutionalise closer collaboration by establishing a secondment program for non-government stakeholders into ASCA, including for leadership roles. Such roles could also be opened to close international partners, like the US. Fresh perspectives could help positively disrupt the organisational culture. Industry and academia would also gain insights into Defence requirements.

ASCA should support existing initiatives that foster partnerships and goodwill with industry and academia. This includes industry days, like those previously hosted by the Army and the Defence Innovation Hub, to showcase prototypes and concepts.

ASCA should also link in with research initiatives like the AUKUS-focused Security & Defence PLuS initiative (between Arizona State University, King's College London, and the University of New South Wales) and the Defence Trailblazer initiative (between the University of Adelaide, the University of New South Wales, industry partners and the Federal Government).

In order to drive engagement with its missions, ASCA could adopt the 'prize challenges' approach used by innovation agencies in many countries to spur R&D in nationally significant areas. The US DARPA has successfully used this model to accelerate defence-relevant research in priority areas like robotics and cyber. Such challenges encourage new ways of thinking and broader participation than regular contractual and grants processes, and the results often far outweigh the prize sum.

After its first 18 months of operation, government should move ASCA outside the Defence portfolio, where it would benefit from bureaucratic independence, lean institutional structures and a standalone culture. As a standalone agency, ASCA would need champions at the highest levels of government. Sitting outside the Defence portfolio could also support ASCA eventually taking on a more prominent role in broader national security innovation, once its organisational arrangements are more settled. This includes linking in

with early-stage research programs like the A$18 million National Intelligence and Security Discovery Research Grants jointly funded by the Office of National Intelligence and Defence and administered by the Australian Research Council.

Strengthening international collaboration

International collaboration plays a critical role in Australia's approach to defence innovation. Australia already has deep and longstanding national security-related science and technology collaboration with its closest partners. This includes bilaterally and through constructs like the Five Eyes Technical Cooperation Program and the AUKUS innovation activities as part of Pillar 2 on advanced capabilities.

International engagement would need to form a key component of a refreshed defence innovation strategy. The strategy should address how Australia and its closest partners can better combine their capabilities and capacities in defence innovation. This would need to be informed by an understanding of areas of complementarity – or gaps – in science, technology and innovation among key defence partners.

After identifying shared priorities with partners, Australia could develop an enhanced program of joint scientific research. This could reduce costly R&D at a time when many governments are facing fiscal challenges. It might also help address the workforce challenges for specialised talent. Such a program should aim to leverage Australia's outsized scientific achievements in areas like quantum physics.

ASCA could be used to provide the institutional home for international collaboration on technology acceleration activities. This includes with the US and UK as part of AUKUS Pillar 2. ASCA could also connect in with novel approaches to technology acceleration being pursued by other international partners like the Allied Nations Defence Industrial Base Accelerator platform. This platform is being developed by the International Security Industry Council of Japan, the Pacific Impact Zone, and the Pacific Northwest Acceleration Center to foster government, industry and civil society defence industry collaboration among the US, Japan, UK, Australia, India, and NATO countries.[65] Given constraints in the defence industrial bases of likeminded democracies, new experimental approaches to defence innovation with a wider range of partners will be important to achieving national and collective defence aims.

↓ Five Eyes panel at Australian Defence Technology and Research Summit 2022

↑ Anduril Ghost Shark (L-R) Director General Warfare Innovation, Royal Australian Navy, Commodore Darron Kavanagh, Interim Head of ASCA, Defence Science and Technology Group, Professor Emily Hilder and Senior Vice President Engineering, Anduril, Dr Shane Arnott stand with the 'Dive-LD' autonomous underwater vehicle at Anduril Australia's Sydney Harbour base.

Conclusion

Australia's defence innovation ecosystem underpins the Australian Government's capacity and capability to defend and advance the national interest.

Remaining at the cutting edge of technology advances is vital to being able to develop asymmetric capabilities in areas like undersea warfare that could contribute to the deterrence of hostile powers in the Indo-Pacific.

This central role of science and technology to defence strategy was evident in the DSR, and is also a key premise of the AUKUS strategic partnership with the US and UK. And yet, current shortcomings in Australia's defence innovation ecosystem risk leaving the ADF ill prepared to contend with dangerous strategic circumstances in both the near and the long term. This includes cultural and bureaucratic challenges, as well as funding.

Modest changes to defence technology acceleration through the establishment of ASCA are a step in the right direction. But broader and more disruptive defence innovation reforms are urgently required to prepare Australia for a more challenging strategic environment in the future. The government must grapple with longstanding challenges like flatlining government investment in R&D, risk aversion among decision makers, and limited research translation success.

Government needs a holistic strategy that articulates Australia's aspirations for defence innovation and clearly identifies priorities and how these link to policy, programs and funding. This needs to be supported by an understanding of international best practice. It must also consider how models like open innovation can be used to quickly re-purpose commercial technologies for military effects.

Defence also needs to foster closer collaboration with industry and academia in support of its innovation agenda. Creating institutional structures that promote closer integration, such as a secondment program as part of ASCA, are an important part of the reform agenda. Working across sectors is important not only in the domestic context. ASCA should be used to support joint scientific research and technology acceleration with international partners to build collective capacity and capability.

Australia cannot pursue similar approaches to defence innovation and expect a different result. Only transformational change will yield transformational results. In the current strategic environment, the question is not whether Australia should pursue bigger reforms, but just how quickly they can be enacted to protect and advance the national interest.

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THE FUTURE OF THE AUSTRALIA – U.S. ALLIANCE

THE ALLIANCE NETWORK PROGRAM

This Black Swan Strategy Paper has been developed as part of the Alliance Network Program. This program supported by the Embassy of the United States of America, is a multi-year public diplomacy, research and engagement activity designed to bring together influential leaders and emerging scholars currently specialising in regional security, economics or public policy to discuss the state of the Australia-United States Alliance and explore new areas of knowledge.

The first itineration of the program, developed by the Perth USAsia Centre under the direction of Professor Peter J Dean, took place on 13-14 February 2020 at the Strategic and Defence Studies Centre at the Australian National University. The subsequent program in 2021, developed by the UWA Defence and Security Institute, held workshops in Perth (UWA DSI), Brisbane (Griffith Asia Institute), The University of Adelaide and Sydney (United States Studies Centre) between March and May 2021. The workshops were designed to ascertain Australian views of the Alliance relationship and were held under the Chatham House Rule to encourage a frank and open discussion. From each of these workshops, a small number of emerging and early career scholars were selected to undertake further policy work and travel to Washington DC to engage with US think tanks and policy makers. This Black Swan Strategy Paper represents a policy discussion from one of these emerging scholars.

About the UWA Defence & Security Institute

The UWA Defence and Security Institute (DSI) is an initiative by The University of Western Australia (UWA). Hosted at UWA, the DSI unifies and focuses UWA's expertise in defence and security research, engagement and education. Defence and security provide the foundation of our nation's sovereignty. In an era of rapidly evolving geopolitics, this critical area of national policy sits at the forefront of government and public debates. The DSI plays a central role in helping to develop Australia's sovereign defence capabilities in WA by working with local, state and federal governments, industry and business, research institutions and the community to help generate solutions towards a peaceful, prosperous and secure Australia and Indo-Pacific region.

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UWA DEFENCE & SECURITY

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