THE WARREN CENTRE

# Inquiry into innovation and creativity: Workforce for the new economy

House of Representatives, Education, Employment and Training Committee, update for January 2017

## Education and The Warren Centre

The Warren Centre brings industry, government and academia together to create thought leadership in engineering, technology, and innovation. We constantly challenge economic, legal, environmental, social and political paradigms to open possibilities for innovation and technology and to build a better future. The Warren Centre advocates for the importance of science, technology and innovation. Our 30 years' experience of leading the conversation through projects, promotion, and independent advice drives Australian entrepreneurship and economic growth.

This submission forms our response to the Education, Employment and Training Committee inquiry on adjustments to the tertiary system to meet the needs of a future labour force focused on creativity and innovation. We welcome the opportunity to submit an updated paper. In this update, we specifically focus on the following terms of reference:

- The extent to which students are graduating with the skills needed for the jobs of today and of the future
- Opportunities for generating increased economic activity, including further investment and jobs, through greater synergies among publicly funded research agencies, universities and other Australian research institutions with businesses and industry; including but not limited to: co-location, cluster formation and development of precincts between university and industry
- Relationships between tertiary education entrepreneurship programs and public, private, and not-for-profit incubators and accelerators

Our thoughts on factors that discourage closer partnerships between industry and the research sector, focusing on culture, collaboration and intellectual property, is the basis of our first submission made in February 2016. We welcome the committee to reconsider that submission as well in this policy consultation process.



**The Warren Centre for Advanced Engineering Ltd**
School of Information Technologies Building J12
University of Sydney NSW 2006
T: (02) 9351 3752 • F: (02) 9351 2012

E: warrenc@sydney.edu.au • W: thewarrencentre.org.au
twitter.com/thewarrencentre • facebook.com/thewarrencentre

ABN: 27 132 821 688

## Executive Summary

Making the transition from a resources-based economy to a knowledge and ideas-focused economy requires changes in collaboration, better recognition of intellectual property and changes in culture. The economic prosperity that accompanied Australia's resources boom is cause for celebration, but significant changes are required in the way the public, business and universities view future opportunities to maximise productivity in the global knowledge economy.

To ensure that the Australian tertiary sector evolves to meet the challenges of the new economy, we make the following recommendations:

1. Greater collaboration is needed between industry and universities. Funding incentives could be used to drive changes in behaviour.
2. Innovation precincts, clusters, incubators and accelerators enhance interaction of personnel, know-how transfer and skills development among universities, research units and commercial entities. Proximity facilitates interaction, and interaction can build the understanding, cultural awareness and collaborative relationships that yield technical success and positive economic outcomes.

## What is the future economy?

The rapid change of competition and the speed of innovation have forced the private and public sectors to seek new partners in their quest for ideas, innovation and competitive advantage. A wave of digitisation is forever changing business. From driverless cars in the streets of major global cities, to robots detecting light and colour patterns and performing tasks with dexterity and precision, to deep learning and artificial intelligence analysing stock markets and assessing financial transactions, automation is an unstoppable force with resultant disruption (Brynjolfsson & McAfee, 2014). Creativity and skill underpin technological change, and an innovative society fosters the appropriate knowledge and imagination to develop the ability to design, engineer, manufacture, diffuse, adapt, choose and use technologies (Dutta, et al., 2015).

The role of the tertiary education sector, therefore, becomes integral in technology creation and value capture in the future economy. Universities must be incubators and demonstrators of highly advanced technologies (World Economic Forum, 2016). The processes along the line from technology creation to adoption to value capture will be focused on how well an economy's universities can transfer technology and improve innovation and business sophistication. According to the Global Innovation Index

2015, the evidence suggests that Australia is less efficient than similarly developed countries in transforming innovation inputs to outputs (Office of the Chief Economist, 2015). To maximise productivity, citizens must be well prepared for the future economy and the unique challenges foreseen. The tertiary sector must evolve to include broader technological leadership as a part of its agenda.

## What does it mean for Australia?

Preparing Australia to meet the unique challenges of the new economy is imperative for continued prosperity. Adapting practices and adopting new approaches for the present labour force are only part of the solution. We addressed other key elements in our Disruption Inquiry paper submitted to the Productivity Commission in February 2016. The more significant challenge is in education and preparing the future workforce for the future challenge. The present Commonwealth NISA initiatives set an excellent direction for innovation and revived entrepreneurship. As the resources boom slows and the 'ideas boom' commences, it is important that the tertiary sector responds to the government narrative around innovation, commercialisation and value capture with university-specific language around technology creation and leadership.

Australia contributes significantly to the global advancement of digital technologies and innovation. Across areas of automation, there are several leading research universities and facilities. Research at the Australian Centre for Field Robotics (ACFR) is at the forefront of algorithm development, artificial intelligence and systems automation. Examples of successful application to industry include the AutoStrads, a fully autonomous straddle carrier currently operating at the Port of Brisbane and in Sydney's Patrick Terminal. According to an Australian Competition and Consumer Competition 2014 report, substantial productivity benefits have been realised. Port operators report that automation achieved a 90% reduction in lost time and medical treatment injuries. The technology, developed in a domestic partnership between the University of Sydney and Patrick Corporation, has since between acquired by Kalmar Global, a multinational shipping and logistics firm, and has been globally commercialised at automated ports in London and other locations. Integrated decision making and systems-of-systems engineering are Australian research specialisations. International collaborative engagement between the University of California Berkeley and the ACFR led to a joint entry to the DARPA Autonomous Vehicles Grand Challenge in 2007 paving the way for know-how and technology creation that is now part of the Centre for Intelligent Vehicles Research. These technical capabilities not

only improve productivity and generate significant economic value, but also protect human life.

Australia has produced leading health technology commercialisations, especially biomedical devices. Much of Australia's biomedical commercialisation success began in universities. Biomedical implant innovation was commercialised by Cochlear from foundational research in the 1970s at the University of Melbourne. A variety of firms have since emerged from successful university-to-industry technology transfers. ResMed is a leading example. New companies such as Nanosonics and Saluda contain a significant number of 'alumni' from upstream companies in the Australian biomed corporate community. The base of community capability in R&D and industrial/ commercial know-how from early firms gives these new Australian firms a global edge, a sort of head start compared to research communities who are arriving late and catching up in the biomedical innovation race. In September 2016, Nanosonics cracked the $1bn valuation barrier with a CEO holding former experience as an SVP at Cochlear and a new Senior VP of Design and Development who was formerly the R&D chief at ResMed. Tacit knowledge and talent flow freely from universities to near-campus incubators, to established companies and to the next generation of new start-ups in ecosystems of technology creation and commercialisation.

Research organisations such CSIRO and Data61 (formerly NICTA) bridge the divide between universities and industry and have created numerous technology spin-offs around 3D mapping, data visualisation, intelligent transportation, internet of things and social media. Incubators, accelerators, hubs and aggregators, such as Stone and Chalk, Fishburners, Incubate and Cicada Innovations (formerly ATP Innovations) in Sydney host start-ups aiming to crack automation, decision-making and connectivity opportunities.

According to the World Economic Forum report, *'The Future of Jobs'*, the industries that will lead to the greatest drivers of change include mobile internet, cloud technology, processing power, new energy supplies, internet of things, sharing economy, artificial intelligence and robotics (World Economic Forum, 2016). Australia plays a significant role in each of these emerging technologies.

## Australia and tertiary education

Tertiary education is Australia's largest service export and fourth largest export overall behind iron ore, coal and gold (Hon. Christopher Pyne MP, 2015). The economic footprint is valued at $17 billion per annum with roughly 600,000 full fee-paying

international students enrolled in 2014 (Dodd, 2015). Australia's value capture as an educational provider is already a vital contribution to our national economy. Translating the research and productivity benefits realised through student populations and ensuring that educational programs are constantly updated to match future needs are necessary to continue holding and to extend our comparative advantages.

Despite noted success stories, we recognise serious and previously well-articulated limitations in university-industry partnerships which hinder the ability of universities to innovate. We also note the need for synergy as well as competition between universities and industry to promote positive outcomes in skill development, technology creation and value capture. In this submission, we specifically refer to the terms of reference requesting information on opportunities for generating increased economic activity, including further investment and jobs through greater university/industry synergies.

## How should tertiary education better serve national innovation needs?

Collaboration and cooperation

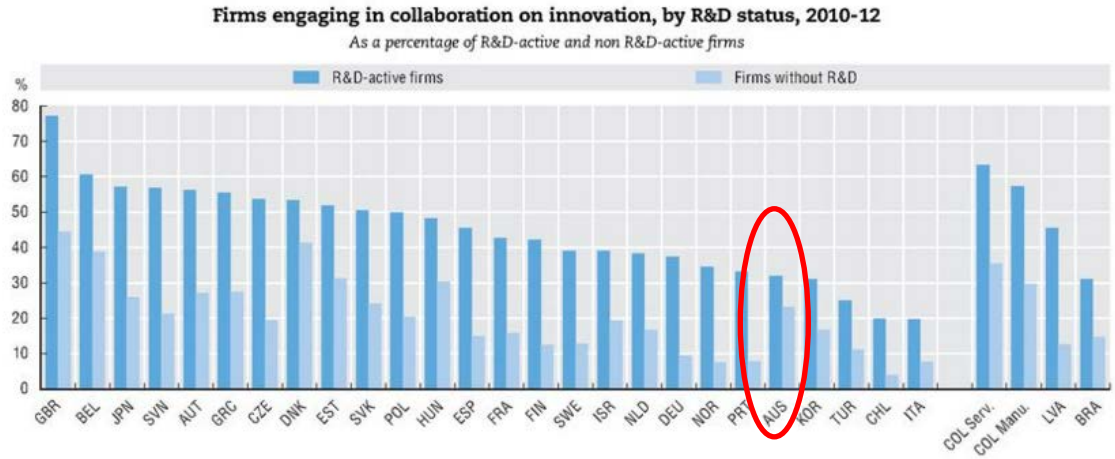


*Figure 1: Firms collaborating in innovation (published in 2015 OECD Scorecard)*

Collaboration and cooperation are frequently cited as a limitation in the Australian national innovation system. Figure 1 shows that Australia consistently ranks amongst the lowest in firms collaborating as reported by the OECD 2015 scorecard. This is despite Australia's total research output ranking amongst the top ten countries worldwide. Collaboration and cooperation have a multiplying effect on innovation, technology commercialisation and value capture abroad. For Australia to gain these benefits and for Australian students to be well prepared for future challenges, it is important that working with industry becomes a part of initial training. Overseas, a

variety of methods that increase university/industry collaboration and cooperation are documented in the ACOLA '*Securing Australia's Future 09*' report (Bell, et al., 2015). Australia can assess the lessons learned from programs such as Finland's 'Creating business from research ideas' or Canada's 'idea to innovation grants'. However the solution for Australia will uniquely reflect domestic technology strengths and workforce capabilities (Bell, et al., 2015).

There is a broad cultural disconnection between the current government narrative and academia's understanding of their role in national innovation. Recognising the intrinsic long-term productivity potential of early-stage research as well as the importance of enterprise linkages with maturing technology creation is imperative. To this end we support two distinct conclusions reached by Australian government business units, the Office of the Chief Economist and Universities Australia. The Office of the Chief Economist in the Australian Innovation System Report 2015, quoted the World Economic Forum and derided Australia's business sophistication. Australia ranked 27th in the world in a metric that examined factors including: cluster development, value chain breadth, control of international distribution and production process sophistication (Office of the Chief Economist, 2015). Similarly, the Global Innovation Index ranked Australia 23rd for business sophistication. In the future economy, a key area for business sophistication will come from universities as technology incubators. There is a distinct difference between 'picking winners' and acknowledging the strong structural technology changes occurring in the economy. Policy makers should acknowledge opportunities in global technology markets where Australia possesses a competitive position, and policy should be set with awareness of overseas high tech sectors so that local businesses have a chance to capture value. Universities Australia in their 2013 report Australia's Higher Education Agenda 2013-2016, states that for Australia to capture the benefits of the upcoming decade, broad university reform in the areas of research commercialisation and university culture is required, specifically with reference to where it sits in a broader innovation space (Universities Australia, 2013). Common understanding of global value chains is needed to build industry for the future. Awareness and adaptation for the global market of 7 billion consumers is needed, not just 25 million domestic users of high technology products and services.

In our experience, mismatched expectations related to development of intellectual property is a constant source of frustration for business and academia. Sophistication in Australian IP collaboration is poor.

Clusters and precincts

The benefits of clusters extend beyond economic outputs such as technology development or the formation of start-ups. Indirect benefits will prove to catalyse systematic competitiveness. These include broader creation and acquisition of technology, knowledge and talent. Further, localised 'know-how' and internationally recognised expertise will allow Australian companies to compete more effectively in international supply chains and bring value home. Examples such as those provided above of AutoStrads and biomedical implants provide clear examples of existing Australian knowledge and talent clustering.

The benefits of clusters and precincts as places of knowledge agglomeration and spillover are well understood and have been well articulated in literature. The economic benefits of geographical localisation of talent and investment had been articulated by Krugman (1991) and Porter (1998) in the 1990s. Breschi and Lissoni (2001) and Bresnahan (2001) studied knowledge spillovers and classified university and industry individually as agencies of the 'old economy' which in turn are now inputs for a 'new economy' output. Most recently Rosenzweig (2016) argues that knowledge spillover generated in a cluster of universities and industry is now an essential indicator for strong economic performance. The paper shows that what is done with new knowledge and ideas (the economic translation) matters as much as the investment into the production of new ideas and knowledge. In particular, it is the ability of a country to develop diversified technologies and commercialise across diversified markets that best indicates its ability to compete and capture value. The function of a cluster or precinct as a developer, incubator and 'tester' of technologies across markets means that the formation of these clusters and precincts is becoming increasingly important for Australia's innovation future. Universities should be at the centre of these types of clusters because of their ability to incubate new technologies and to develop fundamental understanding and knowledge. Students exposed to this university/industry nexus will emerge from their degrees better acquainted with the role of technology in all areas of life and better prepared to apply their education in creative ways.

Development of knowledge clusters in Australia (through CRC programs, industrial centres for excellence and industry precincts) are therefore supremely valuable. CRC programs rank amongst Australia's most successful cross-industry programs. The CRC of Advanced Composite Structures has produced over 100 industry-ready PhD graduates, facilitated hundreds of millions of dollars of commercialisation outcomes and brought dozens of SMEs into the local and international industrial value chains through collaborative research engagement (CRC-ACS). The Allen Consulting Group

in a 2012 study found that the program is highly beneficial in engaging researchers with domestic and international end users and has shown a 3:1 return on investment.

Enhancing and extending successful cross-industry programs such as CRCs as well as industry/university bridges such as CSIRO and Data 61 is very important. Incentivising technology commercialisation results and outputs from universities would catalyse further partnerships between university and industry. To train the next workforce, industry could be incentivised to engage further with students and influence professional formation.

In '*Engineering a collaborative future*', Dean Archie Johnston from the University of Sydney stated that industry projects are sought by students specifically because of their relevance and applicability to workforce capability (Young Engineers Australia; The Warren Centre for Advanced Engineering, 2016). In particular, allowing and incentivising industry access to student talent through increased internship programs, mentoring, summer projects and honours theses ensures that research output is targeted to practical challenges of the future economy and that students are gaining experience and expertise instantly relevant to evolving market needs.

Incubators and accelerators

University incubators and accelerators are a vital initial proving point for young persons and retraining adults to begin a journey in entrepreneurship and business-building for the new economy. University incubator programs and 'pitch' nights create safe spaces for entrepreneurs to test ideas, to learn new skills outside traditional degree boundaries and to experience the thrills of building business prototypes, of succeeding and of failing within a safe environment. Such programs are a vital launching point to the innovation economy. By creating a culture of risk-taking and entrepreneurialism while students are still undertaking formal education, universities can be essential seeds to further innovativeness and successful technology creation. A culture whereby students begin their entrepreneurialism in university under the auspices of a university incubator and then continue developing their ideas and commercialising through commercial such entities will prove to be highly valuable for the economy. A precinct where this is an interdependent and independent process has the potential to catalyse future value creation.

University and industry cultures are distinctly different, and barriers can inhibit collaboration. The 'soft side' of research collaboration relationships is frequently overlooked, and failure can result from non-technical causes (Plewa and Quester,

2007) Clusters, precincts, incubators and accelerators build cultural linkages and soft bridges that can increase success.

## Conclusions

Funding incentives could be used to drive changes in behaviour that yield greater collaboration between industry and universities. The correct balance of 'blue sky' science versus applied technology and programs that enhance university-industry collaboration could build economic outcomes.

Innovation precincts, clusters, incubators and accelerators enhance human interaction. Proximity and facilitation programs transfer know-how and develop skills critical to collaboration among universities, research entities and industry. Previous Australian examples and international examples show the benefits.

The Warren Centre looks forward to discuss this submission or provide further analysis to support and amplify any aspect of this submission.

## Contact

Ashley Brinson
Executive Director, The Warren Centre for Advanced Engineering
ashley.brinson@sydney.edu.au, (02) 9351 3752

## About the Warren Centre for Advanced Engineering

The Warren Centre constantly challenges the economic, legal, environmental, social and political issues raised by innovation. We collaborate with industry, government and academia to achieve globally significant outcomes.

http://thewarrencentre.org.au/

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