

Disruptive Technologies

Productivity Commission Inquiry, 2016

Disruptive Technologies 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 forms the response by the Warren Centre for Advanced Engineering to the Productivity Commission inquiry titled, '**Disruptive technologies: what do governments need to do?**' The objectives of the study are to examine the potential impacts and challenges of innovation and disruptive technologies for competition, productivity, structural adjustment and social structures.

Executive Summary

The Warren Centre believes that Australia's policy should enable rapidly advancing technologies and companies to thrive while ensuring that the social fabric of our society remains secure. In particular we respond to this inquiry by studying (and celebrating) the impact of rapid technology improvement on competition and productivity and by suggesting measures to tackle the challenges of social structural adjustment.

To ensure Australian technology leadership and social sustainability, we make the following recommendations:

1. Prioritise digital literacy and STEM education across primary, secondary and tertiary sectors. Allocate resources to STEM training for teachers and leverage digital learning models such as massively open online courses (MOOCs) to enhance the learning experience and gain further analytics
2. Prepare citizens for the economy of the future by recognising shifts in career patterns and education requirements to enable lifelong learning and re-training.



Reform education programs broadly to support adaption to foreseeable structural changes in the global economy.

3. Incentivise innovation, technology creation and entrepreneurship throughout all tiers of the national system of innovation from fundamental research through to commercialisation and adoption.

4. Proactively assess the peer-to-peer and 'share economy' models and re-evaluate the necessity of government intervention for regulatory reform to permit broad Australian innovation, technology creation and value capture.

5. Undertake a long-term policy discourse to explore our national approach to labour, wealth distribution and the potential effects of shrinking middle skills employment due to automation and artificial intelligence. Evoke Australia's history of strong social security debate across conservative and liberal ideologies and our strong progressive social security tradition to lead this public discourse.

Technology growth over the past centuries

In the 18th and 19th centuries, steam power, machines and steel production came together to produce one of the greatest periods of economic and creative productivity in the history of mankind. The collective growth of what we now regard as commoditised 'technologies' enabled and accelerated business activity, creative industries growth and an industrial and resources revolution. The manufacturing industry that was borne out of that period became the basis of Western economies throughout the 20th century.

Steam initiated the industrial revolution precisely because it allowed humans to overcome limitations in muscle power to generate massive amounts of useful energy. The trend of commoditized technology overcoming limitations in productivity yielded enormous increases in quality of life through the 20th century. Technologies that we view as antiquated today were viewed as awesome disrupters in their day. The steam engine disrupted the horse and buggy; the internal combustion engine disrupted steam.

In recent years, Google's autonomous cars have logged thousands of kilometres on California's roads, IBM's Watson beat the best human players in the game *Jeopardy*, and computer-guided automation is creeping into everything from advanced manufacturing to decision making (Rotman, 2015). A standard commercial aircraft can take-off, cruise and land completely by itself while still interpreting updates and communication from air-traffic control and neighbouring aircraft (Brynjolfsson & McAfee, 2014). Robots like Baxter can now perform the same tasks as humans with dexterity and precision and without necessity for sick leave, vacation, office-hours or productivity lapses.

It is evident that digital technologies are progressing faster than ever. These technologies are not 'new' - Time magazine declared the personal computer its 'Machine of the Year' in 1982 - but they are maturing (Brynjolfsson & McAfee, 2014). There is still a steep growth curve ahead as digital technologies continue to bring

remarkable transformation to industry and society, but we appear to be past the inflection point (Schmidt & Cohen, 2010). The transformation now will be rapid and unforgiving. The transition from manual labour to automation, manual processing to digital decision making and human-in-the-loop to completely autonomous operations will need to be carefully considered, but deep automation appears to be an irresistible force. The transition will forever affect our patterns of consumption, production and employment (World Economic Forum, 2016). In particular, concurrent to technology creation is a set of broader socio-economic, geopolitical and demographic drivers of change which will be both interdependent and independent of technology growth (Schmidt & Cohen, 2010). New business models such as peer-to-peer and 'share economy' are socially acceptable, even preferable, to the 'Digital Natives' Generation. The Australian government must adopt a proactive approach to assess how best to position Australian society to maximise the productivity potential of emerging technologies while minimising or addressing the social disruption.

What is the technology induced jobs 'crisis'?

Several statistics put this statement into context. Understanding of this social transformation has also developed rapidly over the past few years. A report in 2013 by the McKinsey group found that up to \$9 trillion in global wage costs could be saved as knowledge-intensive tasks such as analysing consumers' credit ratings and providing financial advice is automated using artificial intelligence (AI) and computers (Maniyka, Chui, Bughin, Dobbs, Bisson, & Marrs, 2013). Further, McKinsey analysed the disruptive potential of twelve game-changing technologies (including advanced robotics, internet of things, autonomous vehicles, next-generation genomics, energy storage, advanced materials, 3D printing, renewable energy and mobile internet) and estimated that the global potential economic impact could be between USD\$14 trillion and \$33 trillion a year in 2025 (Maniyka, Chui, Bughin, Dobbs, Bisson, & Marrs, 2013). Researchers at Oxford University have stated that this technology revolution could leave up to 35% of workers in the UK and 47% of workers in the US displaced by technology in the next 20 years (Stewart, 2015). A Brookings Institute report this year estimates that technological disruption could affect some 20% of GDP and 40% of jobs globally by 2030 (Dervis, 2016). Most recently, a January 2016 World Economic Forum report predicts that there will be a net loss of 5 million jobs caused by automation and robotics over the period of 2015-2020. These findings are based on a survey of 15 economies that account for 65% of the world's total workforce. The jobs most at risk are office and administrative roles (World Economic Forum, 2016).

However in the short-term, despite the advanced capability of robots, digital labour is still far from a complete substitution for human labour. Although AI technologies like IBM's Watson are being rapidly applied across healthcare, finance and administration, presently pragmatic economic impacts are limited (Brynjolfsson & McAfee, 2014). Human intervention and labour remain critical for developed and developing economies. Notably, the net loss of 5 million jobs by 2020 as predicted by the World Economic Forum includes a gain in 2 million jobs in computer, architecture, mathematical and engineering related fields. The dialogue should focus on how Australia can future-proof our economic productivity and social structure so that the

benefits of advancing digital technologies can be realised with minimum social structural damage.

What is Australia's role?

Australia is not immune from digital disruption. Uber's rise was one of the biggest digital disruption stories globally and here in Australia (Hudson, 2015), and the foothold that Uber gained in the private transportation market was obtained while the legality of its most popular ridesharing model was still contentious and unresolved. Indeed now Uber operates across nine cities in Australia and New Zealand and has over one million users and 15,000 drivers, but permissive regulations were not implemented in most states until the last months of 2015. This highlights how rapidly and deeply an industry can be disrupted before regulatory control responses are devised. A proactive foresight approach is necessary by government.

Australia is not only feeling the effects of foreign-sourced disruption. Our nation also contributes a significant research and development role in the growth of digital technologies. Research at the Australian Centre for Field Robotics is at the cutting edge 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. Substantial productivity benefits have been realised through implementation of automation technologies at Rio Tinto mine sites (Saulwick, 2015). A major advantage of the stevedores and mining automation developments has been improved site safety and reduction of serious injuries and fatalities. Research at the ACFR on robotic agricultural mapping and harvesting is developing technologies for localisation, path planning, visualisation of fruits and effective terrain mobility (ACFR, 2014). Research vehicles such as the Ladybird have been successfully field tested in onion, beetroot and spinach farms in Cowra. The system includes a robotic arm for removing weeds and autonomous harvesting. Integrated decision making and systems-of-systems engineering are also Australian research specialisations. These capabilities improve productivity and generate significant economic value. However they also remove humans from the tasks. Research organisations such as 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 and accelerators such as Stone and Chalk, Fishburners, Incubate and ATP Innovations in Sydney host start-ups aiming to crack the 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 has one of the most enviable social security safety nets in the world. Following a progressive approach since federation, Australia's 'social laboratory' has evolved to include universal healthcare, education, sick-leave and superannuation

provisions as a standard part of our social norm (Herscovitch & Stanton, 2008). Point in time estimates from the Productivity Commission working paper *Tax and Transfer Incidence in Australia* (released in October 2015) confirm that Australia has both a highly progressive social security system and a progressive tax system (Productivity Commission, 2015). The lowest income bracket at less than \$25,000 per year receives on average social security benefits of more than \$18,000 per year while effectively paying no income taxes, whereas the highest bracket income earns between \$175,000 and \$200,000 and receives benefits of around \$120 per year while paying nearly \$48,000 in taxes (Productivity Commission, 2015). Social security debate is well-informed and broad ranging with a variety of participants across liberal and conservative lines. The Australian government can therefore lead the international discourse on social security and progressive labour reform to account for technological disruption, a key recommendation of this paper.

How should the Australian government respond to digital disruption?

Securing Australia's role in the global technological revolution is imperative. Significant productivity and wealth generation opportunities will be created. Some technologies will be evenly dispersed internationally and some will be concentrated like the gains of the early industrial age. Australian innovators can build sustainable national wealth. Domestic wealth distribution is a vital secondary question to be addressed. To tackle the domestic and international competition labour force challenges, we must first grow the economy. We must push to ensure that Australian comparative advantage allows us to engage and participate in international supply chains. Australia's social safety net and strong democratic public dialogue are benefits that enable broader social discourse regarding the future of labour and payment/benefit models.

1. Digital literacy, STEM education and preparation for uncertainty

Developing a highly skilled workforce and targeted skilled migration is key. The Warren Centre recommends strong investment in Science, Technology, Engineering and Mathematics education across primary, secondary and tertiary education. We highlight our proposed positions in our *Vision for a Nation: Science, Technology, Engineering and Mathematics* paper. Importantly our national STEM strategy must not only incentivise technology and engineering literacy amongst students but also tackle serious functional STEM deficiency amongst professionals tasked with teaching. Significant resources must be directed towards educating teachers in the discipline of computer science and the competency skills of coding. Using technology as a teaching tool in online programs such as Massively Open Online Courses (MOOCs) offers a wider resource to leverage information and stimulate awareness, involvement and excitement. In particular students can access exciting science demonstrations, insightful explanations of Renaissance art and the most helpful methods of learning statistical techniques (Brynjolfsson & McAfee, 2014). MOOCs and similar platforms also offer a subtle benefit of creating large streams of usage and uptake data. This enables national education strategies to be targeted and incentivised based on analytics. By investing in early-stage digital literacy, Australia can be poised to meet

the technology challenges of the future with an engaged and active workforce. In the meantime, migration of skilled workers should be welcomed, and appropriate visa programs can fill skills shortages.

In the global knowledge economy, education is not a process confined to children and young adults. Australian citizens need lifelong learning skills and public support institutions to cope with potentially rapid technology shifts. The market currently evolving seeks creativity and collaboration. Workers and entrepreneurs who can navigate uncertainty fare better than rigid and inflexible employees and business owners. Education institutions must prepare for the economy of the future, not the economy of the past. Schools should teach future oriented problem solving appropriate for the developing transnational orientation of markets. Citizens that can sense disruption and adapt to reinvent their careers and businesses will make Australia wealthier and more secure with less necessity for governments to bail out individuals and industries when shocks occur. Portfolio careers are more common than the previous century, and peer-to-peer business models like Uber, Airtasker and Freelancer accelerate the trend.

Rapid digital technology development is not the only cause for future disruption. Transformative climate change adaptation is required. Rapid development in genomic technology requires new thinking in bioethics and intellectual property law. As improvements in health and longevity create demographic change, expectations and demands will change in employment patterns, infrastructure needs and health services for an ageing population. Climate and ageing may exacerbate technology disruptions. Australian governments must responsibly acknowledge science and educate the public.

Technology changes occur internationally without respect for national or state boundaries. The “Google tax” debate and chaotic regulatory response to Uber show how government responses lag changes in technology and business strategies undertaken by the global technology industry. The savvy use of social media by the tech industry creates a new voice and political force. Governments must avoid cynical, self-serving politicization to lead and unify the nation to adapt to future uncertainty.

2. Digital infrastructure, innovation and a national approach

Central to ensuring Australia’s international capability in digital technologies is building our capacity to innovate. Invention and modernisation must be incentivised throughout all tiers of the national system of innovation. Development of knowledge clusters (through Industry Growth Initiatives, CRC programs, industrial centres for excellence and industry precincts) must continue and expand. Fundamental research and collaboration with industry must be supported and further developed. Agencies like CSIRO and NICTA bridge the divide between academia (whose purpose is to educate as well as research) and industry (whose purpose is commercial.) Further, financial policies incentivising innovation are key to developing the environment. Tax reliefs for R&D need to be appropriately managed and stabilised to ensure that they are achieving the correct outcomes and performing their intended function. Simplifying rules for equity handling and raising debt capital will allow small companies to engage in broader markets and diversify their financial risk. Allowing and supporting companies

to engage in globally competitive supply chains will bring investment for innovation into Australia and will further develop Australian technology leadership abroad. The National Science and Innovation Agenda and various Industry Growth Initiatives are strong positive commitments towards the needs.

In particular the ability of the Australian marketplace to sense and set trends in global technology adoption will prove to be vital. This will be guided by university research and commercialisation. Research universities can be incubators for new discoveries and innovations, but follow-through to commercialisation is imperative. Academic training strategies to educate on appropriate intellectual property strategies, commercialisation and value generation will be part of the puzzle to achieve this leadership. The other part is enhancing collaboration between industry and academia.

3. Regulatory changes for the new economy

Governments should avoid entry barriers that create regulatory oligopolies. Regulations should not stifle innovation. Rapid increases in efficiency will remove the necessity for government intervention in certain areas. Information asymmetry is changing as consumers adopt new methods to assess quality and value. Governments should continuously reassess how consumer protection policies meet needs in the digital era (Koopman, Mitchell, & Thierer, 2015). Consumers need to be protected, but self-regulation may be appropriate. Consumers are increasingly influenced and dependent upon user ratings. From Amazon to Uber and Airbnb, consumers gauge the quality of products based upon social media style “likes” and ratings. In a self-regulated context, the government’s role may evolve to that of a third party competition and integrity ombudsman verifying the fairness of business methods and the truthfulness of peer-reported quality rating data (Cohen & Sundararajan, 2015).

The share economy, peer-to-peer disintermediation and direct-to-consumer trends decrease prices to consumers, but disrupt existing businesses, especially bricks-and-mortar establishments (Koopman, Mitchell, & Thierer, 2015). In some cases, early-entrant platform builders have built considerable distribution networks and market power. Online retailing has been criticised for social sustainability as internet supply networks replace small shops. Amazon presently only sells books in Australia, but overseas, the platform has rapidly revolutionised online shopping. Domestically, internet home grocery delivery diverts sales from local neighbourhood shops. Government’s proper role is to allow innovation and monitor misuse of market power (Cohen & Sundararajan, 2015).

4. Managing our approach to labour - long term

A long term policy approach is needed to manage labour disruption in the face of automation and digital technologies. Our strong progressive social security net will allow Australia to contribute strongly to international conversations. Some futurists and economists predict a time when the traditional exchange of labour for money may collapse for disrupted citizens who cannot adapt and contribute effectively in a highly automated digital economy. Economists speculate that serious collapse would require fundamental redistribution of the wealth created by radically transformative automation efficiency. One solution proposed is a ‘basic income’ paid to every citizen to provide a minimum standard of living. In such a proposal, individuals add to their basic income

through their own enterprise. Another proposal is a 'negative tax' such that individuals below the taxable income level, receive offsetting compensation to raise their income (Brynjolfsson & McAfee, 2014). According to researchers at the MIT Centre for Digital Business, this combines a guaranteed minimum income with an incentive to work, but only be a short term fix as such plans do not address broader and long term concerns of inequality and lack of social productivity (Brynjolfsson & McAfee, 2014). Other options presented by the MIT Centre for Digital Business include (Brynjolfsson & McAfee, 2014):

- A national mutual fund widely distributing a portion of the country's ownership of capital to provide a dividend stream to all citizens to assure that capital returns do not become too highly concentrated.
- A vouchers system for basic necessities like food, clothing, and housing, addressing extreme inequality but still allowing the market to manage income above a minimum level
- Large scale government hiring or indirect hiring through spending and contracting to the private sector to invest in infrastructure, education, technology, clean energy and the environment

Other potential options include:

- Incentives to established senior entrepreneurs and funders who lend financial and intellectual capital to build Australian capacity and create jobs

Final solutions will require considerable economic modelling considering a variety of inputs. Australia's history of social security debate across conservative and liberal ideologies as well as our strong progressive social security system are distinct advantages to enable this domestic policy debate and to show unique leadership at the global level.

Conclusion

By following the approach outlined in this submission, the Warren Centre believes that Australia will be well prepared to capture the benefits in the coming decade.

The Warren Centre looks forward to discuss this or provide further analysis to support and amplify any aspect of this submission. We are also happy to testify at a public hearing if this is something that is requested by the Productivity Commission.

Contact

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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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