TOMORROW'S DIGITALLY ENABLED WORKFORCE

Megatrends and scenarios for jobs and employment in Australia over the coming twenty years

Stefan Hajkowicz, Andrew Reeson, Lachlan Rudd, Alexandra Bratanova, Leonie Hodgers, Claire Mason, Naomi Boughen

January 2016

acs
BCG DIGITAL VENTURES
Australian Government
Department of Employment
ANZ
DATA 61
CSIRO

CITATION

Hajkowicz SA, Reeson A, Rudd L, Bratanova A, Hodgers L, Mason C, Boughen N (2016) Tomorrow's Digitally Enabled Workforce: Megatrends and scenarios for jobs and employment in Australia over the coming twenty years. CSIRO, Brisbane.

COPYRIGHT

© Commonwealth Scientific and Industrial Research Organisation 2016. To the extent permitted by law, all rights are reserved and no part of this publication covered by copyright may be reproduced or copied in any form or by any means except with the written permission of CSIRO.

IMPORTANT DISCLAIMER

CSIRO advises that the information contained in this publication comprises general statements based on scientific research. The reader is advised and needs to be aware that such information may be incomplete or unable to be used in any specific situation. No reliance or actions must therefore be made on that information without seeking prior expert professional, scientific and technical advice. To the extent permitted by law, CSIRO (including its employees and consultants) excludes all liability to any person for any consequences, including but not limited to all losses, damages, costs, expenses and any other compensation, arising directly or indirectly from using this publication (in part or in whole) and any information or material contained in it.

ACKNOWLEDGMENTS

The authors of this report would like to express gratitude to the many individuals and organisations who kindly shared their time, resources, expertise and knowledge. We are particularly grateful to Michael Priddis whose unwavering commitment to the research, energy, insights and desire to build a better world inspired the team. We are also very grateful to Brad Noakes, Andrew Dyer, Miguel Carrasco, Anita Oh, Josh Masters, Julia Fetherston, Dorothee Ihm, Mythreyi Ragavan, Ryan Cahill, Stefan Leve, Benedikt Alt, Craig Riddell and the team at Boston Consulting Group in Sydney (and worldwide) for forming a unique partnership with CSIRO and guiding the research. We look forward to working with you all in the future. We are grateful to Rayeed Rahman, Lixin Cai, Nick Mowbray and the team at the Australian Government Department of Employment who spent time working with us on the project. We are grateful to Andrew Johnson and the team at the Australian Computer Society who initiated the thinking and continue to give the work impact through their extensive networks. Our thanks to Steven Spangher and the team at ANZ Bank for their support throughout the project and contribution to the consultative workshop. We are grateful to Peter Gahan and the team at the Centre for Workplace Leadership at the University of Melbourne for the two way exchanges of ideas. We are also thankful to Atikur Khan who provided the modelling described in section 6.3 of this report and to Cecile Paris for the detailed edits and valuable comments. Our gratitude to the many individuals who were interviewed in the trends identification phase and to those who attended the workshop at the National Portrait Gallery. Lastly we are grateful to our many internal CSIRO colleagues who have reviewed drafts, provided guidance and supported the research in many ways. We are looking forward to staying in touch with our new and growing ecosystem of colleagues as we continue to work in this exciting and important space.

CSIRO is committed to providing web accessible content wherever possible. If you are having difficulties with accessing this document please contact csiroenquiries@csiro.au.

CONTENTS

Foreword 1

Executive summary 7

1 Introduction 17

2 A snapshot of Australia's labour market today 23

2.1 Employment rates and spare capacity of labour 24
2.2 Youth unemployment 24
2.3 Earnings 25
2.4 Skilled labour – Australia's competitive advantage 25
2.5 Climate change and employment 25

3 Strategic foresight 26

3.1 Strategic foresight method 26
3.2 Expert interview outcomes 28

4 The megatrends 31

4.1 The second half of the chessboard 31
4.2 Porous boundaries 36
4.3 The era of the entrepreneur 40
4.4 Divergent demographics 44
4.5 The rising bar 49
4.6 Tangible intangibles 53

5 The scenarios 57

5.1 Horizontal axis – extent of institutional change 58
5.2 Vertical axis – extent of task automation 60
5.3 Scenario 1 – Lakes 62
5.4 Scenario 2 – Harbours 63
5.5 Scenario 3 – Rivers 65
5.6 Scenario 4 – Oceans 68

6 Technology and employment 71

6.1 Globalisation 71
6.2 Automation 71
6.3 Augmentation 72
6.4 Distributional impacts 74
6.5 Technology and the firm 75
6.6 Market structure 76
6.7 Jobs of the future 76

7 Policy implications 85

7.1 Digital inclusion 85

7.2 Empowering and informing labour market re-activation 85

7.3 New workforce statistics 86

7.4 Education 87

7.5 Workplace relations 88

7.6 The need for choices 89

8 Conclusion 91

References 94

FIGURES

Figure 1 Real wages during (and after) the industrial revolution in Great Britain....19
Figure 2 Unemployment rate....24
Figure 3 Labour utilisation measures in Australia....24
Figure 4 Unemployment rate: general population and youth in Australia....24
Figure 5 Average annual wage in Australia and G7 countries....25
Figure 6 Generic foresight process developed by CSIRO....27
Figure 7 Number of transistors on an integrated circuit at the same cost (Moore's Law)....31
Figure 8 Social media use in Australia....32
Figure 9 Australian Internet subscriptions....33
Figure 10 Terabytes of data downloaded using fixed line broadband in Australia....33
Figure 11 Millions of inbound passengers in Australia....36
Figure 12 Number of co-working spaces and Freelancer.com users worldwide....37
Figure 13 Small business growth pre-GFC....40
Figure 14 Proportion of employees by business size....41
Figure 15 Proportion of total wages paid by small business....41
Figure 16 Potential additional income for small businesses over the next decade....41
Figure 17 Declining Australian venture capital funding....43
Figure 18 Share of working age population 2012 to 2035....44
Figure 19 Life expectancy at birth: trends and projections....44
Figure 20 Workforce projected participation rate by age group....45
Figure 21 Workforce participation rates....45
Figure 22 Higher education students by gender....45
Figure 23 Average effective retirement age in Australia....46
Figure 24 Family and skill streams of migration....46
Figure 25 Prevalence of mental disorders by age and sex in 1997 and 2007....49
Figure 26 Employment growth by skill level with projections until 2019....50

Figure 27 Information technology studies completion trend 50
Figure 28 Performance of Australian students (mean PISA score) in mathematics and science 51
Figure 29 Australian higher degree enrolments by field of study 51
Figure 30 Proportion of bachelor degree graduates working full-time of those available for full-time employment 53
Figure 31 Gross value added by industry (indexed, 1975 – 100%) 53
Figure 32 IP Filings and GDP growth in Australia (indexed 1999 – 100%) 54
Figure 33 Employment growth projections by sectors (2014 to 2019) 54
Figure 34 Work environment preferences of Generation Z 55
Figure 35 Scenarios for jobs and employment in Australia in the year 2035 57
Figure 36 Bank tellers and finance professionals 72
Figure 37 Jobs in photography 73
Figure 38 Employment in graphic design and printing 73

TABLES

Table 1 Employed persons in Australia by industry division (main job, seasonally adjusted) 23
Table 2 Trends identified by interviewees and focus group workshop participants 29

FOREWORD

The CSIRO's 'Tomorrow's Digitally Enabled Workforce' report is an important foundation for policy makers grappling with the future of work in Australia. The findings of the report underpin the work already being undertaken by the Department of Employment to address the impact of rapid technological development, new business and employment models, increasing globalisation and social change on employment and workplace relations.

The analysis of the megatrends outlined in 'Tomorrow's Digitally Enabled Workforce' is a solid base for the development of future-focused strategies to enable people and organisations to take advantage of emerging opportunities – including promoting entrepreneurship, facilitating participation in the online economy, and encouraging the development of new business models. We are looking to policy settings that enable current and future generations of Australians to be well-positioned to support themselves and contribute to our economy and society.

This report marks the beginning of an era of immense change in Australia. The future holds exciting opportunities for the way we work, consume and interact, and also poses some policy challenges. People who work in highly structured environments or who lack high level interpersonal skills may be particularly vulnerable to their jobs being automated. We need to get the policy settings right so that workers who lose their jobs due to automation have access to other streams of work.

We must provide an appropriate safety net while enabling people and organisations to take advantage of new opportunities as they emerge. Regulation needs to accommodate the changing nature of work while providing reasonable protections. There is a need for targeted investment in skills, education and training. Supporting individuals in applying general and transferable skills will be a key priority as we foster a sustainable and more productive economy.

I look forward to working with a wide range of people, both within and beyond government, to help position Australia to thrive in this changing environment.

Ms Renée Leon PSM
Secretary, Department of Employment

On the back of investments in the resources sector petering out, there is a feeling of consensus across the country that Australia needs to reinvent ourselves.

We are seeing a focus on entrepreneurism to create new jobs, working out how to encourage new tech companies that will be competitive on the world stage, while promoting innovation through technology to transform current businesses so that they will thrive in a globally connected market place.

As a relatively small economy, Australia will likely always be a net importer of technology. Large global platforms that have scaled offer far greater affordability than building something from scratch.

So as a nation, we need to be focused higher up the supply chain creating value and generating a livelihood for our country.

What does this look like? Not just for those who are creators of technology and those working in digital professions, but also in terms of employability skills for those users of future technologies.

As the peak body for the IT profession in Australia, ACS has a responsibility to forecast occupations and skill needs to ensure Australia has the high level technical skills required to underpin a successful economy in the future. Which is why we are pleased to be involved with this report.

Industries already have been experiencing digital disruption, while the futurists say that we have historically under-estimated the rate of change. Digitisation and automation will have profound effects on the future labour markets. What are the deep seated trends? And how can we as a country start to plan and prepare so that we maintain our historically high standards of living?

This report provides a critical contribution to starting that conversation.

Andrew Johnson
ACS

ANZ (Australia & New Zealand Banking Group) is pleased to support this important study that is exploring the future of work in Australia.

While change has always happened, the pace of change and in particular the speed of technology change in today's world is unprecedented, and is having a major impact on, and being driven by, changing customer expectations, accelerating technology development, and evolving industry structures and participants. This is also changing the nature of economic exchange between markets and countries.

The impact of these trends and the resulting skills and experience required to support this change must be better understood so that the appropriate measures can be put in place to provide a prosperous and innovative economy and society in Australia for the employees of tomorrow.

Many of the challenges that this disruption throws up cannot be solved by business, government, or academia alone but needs to be tackled in a collaborative way. As a bank and a large corporation we need to build strong relationships with all parties in their ecosystem – existing vendors and partners, fintech start-ups and the bright minds in universities among them.

Intense collaboration across a variety of industries will generate better outcomes in terms of nurturing the technical and entrepreneurial talent present in the Australian community, generating opportunities for the next generation, and helping address some of these issues around skills and capability development at an organisational, and collectively a societal level.

To support this, at ANZ we are in varying stages of building our relationships and the activities that will foster and develop skills and talent:

- We are investing in this study to better understand the future of work in Australia and the role that we can potentially play in it.
- We are investing in start-up and fintech environments such as Stone & Chalk in Sydney and York Butter Factory in Melbourne.
- We are engaging in and contributing to multi-faceted thought leadership activities that seek to explore and address issues around the future of work, with various levels of government and industry.
- We are undertaking innovative projects with many universities across the Asia Pacific region. We have explored platforms for co-created apps with internal and external parties, advanced data visualisation techniques, use of gamification in financial advice, advanced analytics, and other subject areas that are part of the changing technology landscape.
- We are beginning to engage with fintech start-ups themselves to explore possibilities.
- We are providing post-graduate students with valuable commercial experience and real business problems to accelerate their learning and development.

We see our contribution to this engagement as vital to create the opportunities and skills required to help Australia take advantage of the change from the digital future and beyond.

Patrick Maes
CTO and GM Strategy & Planning, Global Technology, Services & Operations (GTSO)
ANZ

BCG works with clients around the world to address their most important and complex challenges. We are delighted to have had an opportunity to collaborate with the CSIRO on what will be one of the greatest challenges of this generation: the future of work. As this report shows, megatrends are driving accelerated and fundamental change in business, government and society. Our own research shows that in Australia, 73% of jobs are likely to be substantially impacted by automation and artificial intelligence by 2035. The rate of automation-driven job destruction over this period has only been surpassed once during the past 15 years (at the height of the Global Financial Crisis).

Rather than being fearful of the future, we believe there are enormous opportunities for Australia to harness the potential of disruption and become more productive, more competitive and win in the global economy. We have many competitive strengths to build from, but there is no silver bullet. Success will require a combination of sophisticated public and private sector interventions. Businesses need to take advantage of the opportunities by embracing transformation and investing in their people. Government will need to continue to play its traditional role to support and manage the social and economic transitions, but to be effective needs to become much more agile and responsive in its own policy and implementation.

We have developed frameworks to help the private sector and government to respond successfully to major transformations and look forward engaging with the early adopters and leaders who are motivated to stay ahead of the game. We are optimistic that Australia can positively harness the opportunity and create a bright and positive future for our children.

I would like to thank my colleagues Andrew Dyer, Mike Priddis and Miguel Carrasco for their contributions to this study. We look forward to a continued collaboration with CSIRO and Data61.

Brad Noakes
Partner and Managing Director, BCG

EXECUTIVE SUMMARY

Introduction

This report examines plausible futures for jobs and employment markets in Australia over the coming twenty years. The narrative of the future is based on a structured process of strategic foresight which identifies megatrends and scenarios.

While digital technology disruption is an important driver, the report covers a comprehensive range of technological, economic, social, environmental and geopolitical trends. The aim is to inform strategic choices of governments, companies, communities and individuals in planning for economic growth, productive industries, rewarding careers, cohesive communities and improved quality of life.

The implications of this report are that workforce transitions – how individuals move from one job to another and how industries move from one labour market structure to another – are crucial. Although change is inevitable, future destinations are not. Based on this narrative of the future, individuals, communities, companies and governments can identify and implement transition pathways that achieve better outcomes.

Why is now any different?

While Australia's workforce is continually changing, the current period in history is characterised by a combination of forces likely to be associated with greater, faster and different transitions than previously experienced. There are several factors creating unique conditions – a *'perfect storm'* – at this point in history:

- The full impact of exponential and/or steep growth in computing power, device connectivity, data volumes and artificial intelligence is yet to be felt within Australia's labour market. We will reach the steeper sections of the exponential growth curves some time beyond 2020. Many existing jobs are likely to be automated and many new jobs to be created.
- The recent ascendancy of the peer-to-peer (P2P) marketplace (Upwork, Freelancer, Kaggle, Task Rabbit etc.) and the rise of platform economics in a globalised labour market characterised by entrepreneurial activity is likely to change traditional employment models. Many P2P models and employment platforms are in the early phases of development and showing signs of rapid growth.
- The ageing population, cultural diversification, retirement pressures and health and wellbeing drivers are set to change the demographic structure of Australia's workforce. In the next decade Australia's workforce will be older and more culturally diversified.
- Australia is entering the post-mining boom era of its economic development and is positioned for diversification into services, knowledge and innovation exports. This is being fuelled by a changing world economy, as Australia's trading partners in Asia transition from the industrialisation-phase of development into advanced-service sector economies.

As a consequence the 'future of work' is receiving widespread and unprecedented attention from governments, research organisations and industry associations across Australia and the globe. However, the picture of future jobs and employment markets is far from clear. There are many possibilities about the changes which could transpire and the policy levers and actions available to achieve improved outcomes.

Strategic foresight methods

The process of strategic foresight developed by CSIRO uses concepts of megatrends and scenarios to describe plausible futures. The term 'megatrends' was introduced by John Naisbitt in his 1982 book of the same title and is now commonplace within the field of strategic foresight.

A megatrend is a deep-set trajectory of change that occurs at the intersection of numerous trends with tighter and more specific temporal, spatial and typological definition. In our work a megatrend happens over a 5-20 year time period. Megatrends develop gradually but eventually reshape the business environment. Scenarios are evidence based stories about the future, based on how the megatrends unfold. Because the future is uncertain, multiple scenarios exist.

Both megatrends and scenarios provide a model of the future designed to inform decisions. As with any model megatrends and scenarios are, by necessity, a simplification and abstraction of a much more complex reality.

What does the future hold? Megatrends and scenarios out to 2035

MEGATRENDS

Megatrends are gradual and deep-set trajectories of change that will at some point reshape the business and policy environment. They typically have a decadal timeframe (e.g. 10-20 years) and occur at the intersection of multiple trends. Trends are more specific patterns of change which typically have shorter duration and relate to specific geographies or issues. This study has identified six megatrends for jobs and employment markets over the coming twenty years:

1. The second half of the chessboard. The explosion in device connectivity, data volumes and computing speed, combined with rapid advances in automated systems and artificial intelligence means that robotic devices can perform many tasks more quickly, safely and efficiently than humans. The growth in technological capabilities is transforming supply chains, reshaping the workforce and redefining jobs. The challenging prospect is that the growth is not linear (constant), but rather exponential. As we move beyond 2020 (and into the second half of the chessboard) things may start to transform rapidly, as illustrated by the following trends:

- The internet of things (IoT) is at the early stages of growth. In 2006 there were two billion smart connected devices, in 2015 there are 15 billion devices. Although expectations vary, Intel predicts that by 2020 there will be 200 billion devices [1]. The internet of things is about to become vastly more functional, with impacts on jobs and employment markets.
- Australia is ranked fourth in the world for active mobile broadband subscriptions. Internet access via mobile phones more than tripled between 2010 and 2013 [2]. In 2014, 12 per cent of the adult population used only mobile devices, up from 10 per cent over one year [3].
- Internet data usage in Australia is growing exponentially. Roughly 2.5 exabytes of data were generated on any given day in 2015, more data than was generated in total since the dawn of time until 2004 [4]. By 2035, 15 billion terabytes of data will be downloaded semi-annually [5]. More data will demand more data analysts. The US alone faces a shortage of 140-190 thousand people with the required analytical expertise [6].

THE SECOND HALF OF THE CHESSBOARD.

Computing speed, device connectivity, data volumes and many other indicators of technological capability are increasing at exponential, not linear, rates. In his book *The Age of Spiritual Machines* Ray Kurzweil uses this analogy to explain the implications of exponential growth in technological capability. The analogy relates to the inventor of chess. The king awarded him one grain of rice on the first square, two on the second, four on the third, eight on the fourth, and so on until all 64 squares of the chessboard had been visited. Kurzweil notes that for the first half of the chessboard the kingdom is not impacted. The rice debt is large but easily manageable. However, the second half of the chessboard (when exponential growth gets going) leads to an impossibly large debt. In the second half of the chessboard the kingdom changes hands. If the analogy is applied to the real data on digital technology trends, the world beyond, say, 2020 might look a lot different as the rate of change becomes so much quicker. Technology-fuelled digital disruption may reshape many kingdoms (markets, industries...).

- It is estimated that 44 per cent of jobs in Australia are potentially at high risk of computerisation and automation [7]. Many new jobs will also be created by technology. We are entering a period of rapid transition.

2. Porous boundaries. Digital technology and the new world of 'platform economics' is changing employment markets and organisational structures. The peer-to-peer (P2P) economy is expanding into many areas and, while freelancing has not yet taken hold in Australia, it is a large (and growing) employment model in other countries. Companies may opt for staffing models which include a smaller number of core staff, with many other roles provided by the freelancer or portfolio worker community.

Jobs of the future are likely to be more flexible, agile, networked and connected. The following trends illustrate this megatrend:

- One in three working Americans is an independent worker [8], [9]. The Australian online company Freelancer connects over 17 million employers across 247 countries [10] with the number of users growing from 1 to 10 million between 2009 and 2014. Almost 88 per cent of freelancers would continue with freelancing even if they were offered a full-time position [11].
- A market for co-working spaces is emerging. The number of co-working spaces operating worldwide has nearly doubled each year since 2006 [12]. In 2012 alone the number of co-working spaces in Australia increased by 156 per cent [12], disrupting the horizon for office leases [13].
- The P2P market allows anyone to participate. Upwork, Kaggle, Innoventive and Freelancer.com allow employers and employees to advertise, promote themselves and access job markets that ordinarily would not be accessible [14], [15]. P2P services (e.g. Airbnb, Uber, Etsy, Madeit, PPost) provide value through convenience, low barriers to entry and increased speed enabling people to transform their free time into paid work.

3. The era of the entrepreneur. The ideal job within a large organisation may not be awaiting an increasing number of future job seekers. This means individuals will need to create their own job. This will require entrepreneurial skills and aptitudes. Digital technology works to the advantage of tomorrow's entrepreneur. Digitally enabled models of lean innovation (the fast fail approach) operate at low cost and scale-up rapidly. Digital provides options for new market entrants to gain a foothold, compete with longstanding incumbents and access a global market. Entrepreneurial skills are likely to be increasingly important for small business founders and employees within large organisations. This is illustrated by the following trends:

- Australian small business demonstrated impressive growth between 2003 and 2007, and the number of small businesses employing 1-4 people increased by 35 per cent [16], [17]. After this period growth flattened largely due to the global financial crisis [18].
- Small businesses account for the largest proportion of employment in Australia – 43 per cent in 2012-13 [17], [18]. The survival rates for small businesses have improved since the global financial crisis [17].
- Australia has one of the world's top five entrepreneurial ecosystems according to a ranking by Ernst and Young [19] and is ranked third globally for overall entrepreneurship attitude by the Global Entrepreneurship and Development Institute [20].

4. Divergent demographics. Along with many other advanced and emerging economies, Australia's population is ageing with growing life expectancies. Retirement ages are likely to push back further and an organisation's employee profile is likely to contain more diverse age groups and more diverse cultural backgrounds. The rising prevalence of diet and lifestyle related chronic illness and an improved understanding of mental health are likely to see these issues feature more prominently in the human resource strategies of large organisations. The following key trends illustrate this megatrend:

- Australia's population and workforce are ageing. Nearly one in five Australians is expected to be over 65 years old in 2035, compared with one-sixth of the population today [21]. Nearly two thirds of the population could become dependent on those in the labour force by 2046 [22].
- Female labour force participation has increased to nearly 60 per cent in 2015 from 43 per cent in 1978 (although it has remained flat since the GFC). Over the same period the number of men in the working age group not participating in the workforce at all has more than doubled [22], [23].
- Chronic and lifestyle diseases are on the rise. Nearly two thirds of Australian employees are overweight or obese [24]. This rate may exceed 70 per cent by 2025 [25]. From 1997 to 2007 the prevalence of mental disorders increased among most of age groups, with higher prevalence in youth and women [26], [27]. Now nearly half of Australians report to have experienced mental health problems [27], [28].
- Migrants arriving in Australia might counteract the ageing workforce and contribute to cultural diversity. Every year, over 80 per cent of arriving migrants are of working age, while only 54 per cent of Australian residents are of working age [29].

5. The rising bar. Increased use of automated systems is raising the complexity of tasks and requiring higher skill levels for entry-level positions. Income growth in Asia is associated with increased educational and skills levels, as well as growing competition for Australia's labour force. Many low skilled jobs are being offshored or automated. The consequence is the likelihood of a raised skills and education bar for entry into many professions and occupations. However, the quality of education and training is also improving in Australia. The higher bar may still be cleared by tomorrow's more skilled-up and better job seekers as illustrated by the following trends:

- Upper secondary education is becoming a prerequisite for entering the labour market [30]: the number of jobs available for highly-skilled labour is projected to more than double in 2019 compared with 1991 [31], [32].
- Science, technology, engineering and mathematics (STEM) knowledge is associated with 75 per cent of the fastest growing occupations, innovations and wage premiums [33]. However, Australian youth demonstrate falling interest and performance in STEM. Today 11 per cent fewer year 12 students study maths than in 1992 [33], [34] and there has been a 35 per cent drop in enrolment in information technology subjects at universities since 2001 [35].
- Australians are likely to face increasing competition, as the number of people with tertiary education is rapidly growing globally. In 2012 every third adult in OECD countries had a tertiary degree [36]. By 2030 China and India are expected to provide nearly half of the tertiary educated people aged 25-34 and over 60 per cent of the STEM qualified workforce for G20 countries [37].

6. Tangible intangibles. Employment growth in the service industries, in particular education and healthcare, has driven job creation in recent times. This is likely to continue into the future as we move to a knowledge economy. Service sector jobs requiring social interaction skills and emotional intelligence will become increasingly important. Also within this megatrend are the new expectations of younger generations entering the workforce. They are connected, technologically advanced, creative and entrepreneurial, and have new perspectives on desirable work environments, ethical issues and communication styles. This megatrend is illustrated by the following trends:

- The number of patent applications in Australia increased by nearly 50 per cent in the period 1999-2013 [38], [39] with the growth rate exceeding overall economic growth. It indicates a transition to a knowledge economy and a rise of knowledge-intense professions.
- Service industries are major employers in the Australian economy [31], [40]. Driven by population growth and ageing, the highest 5-year growth (out to 2019) in employment is projected for health care and social assistance (18.7 per cent) followed by education and training (15.6 per cent).
- Employment in the 'creative economy' has been growing at an above average rate for the whole economy [41]. The sector is contributing 7-8 per cent of gross domestic product growth annually [42].
- Generation Z (born 1995-2009) might demand new work environments. This generation tends to be creative [43], [44] and digitally minded. Nearly 50 per cent of teens are connected for over 10 hours a day [45]. However, members of Generation Z also prefer face-to-face communication over technology facilitated interactions [46], are looking for life-long learning [44], [47] and are hoping to change the world [44]. They are entrepreneurial, with as many as 60-70 per cent wanting to start own business [43], [46].

STEWARDSHIP

FOUR SCENARIOS

Scenarios can be identified by first crafting axes (continuums) of uncertainty and impact. In this study, the axes relate to the extent to which human task are automated using computerised/robotic systems and the extent of structural change in job markets, employment models and organisational designs. When combined the two axes yield four scenarios that capture a range of plausible futures.

The titles draw upon the metaphor of water bodies. Lakes are relatively shallow with minimal water movement (tides), implying shallow technology capabilities and low structural change. Oceans are deep with strong currents to imply deep technology capabilities and high structural change.

IMPLICATIONS FOR INDIVIDUALS, COMMUNITIES, COMPANIES, GOVERNMENTS

The megatrends and scenarios hold implications for the ways in which individuals manage their careers (and those of their children), the ways through which companies manage their workforce and the ways the government regulates and manages the labour market. There are also implications for the education sector.

The following is a summary of the main implications, which are given more detailed treatment throughout the report:

New skills and mindsets are needed for the future

1. **Education and training are becoming ever more important.** There will be fewer and fewer jobs within the service sector of the economy – within which the bulk of Australians are employed – which do not require skills, and/or training qualifications. The bar is likely to continue rising for the foreseeable future. In addition, the workforces of emerging economies in Asia are rapidly increasing their education and skills levels in line with income growth. Ever faster internet connectivity is bringing these new workforces into greater competition with domestic markets. Ensuring access to high quality education and training will be one of the most effective mechanisms for keeping Australians job ready in competitive global labour markets. This isn't new and has been important throughout history. It nevertheless remains as one of the most important implications from this study of jobs and employment over the coming 20 years.

2. **New capabilities are needed for new jobs of the future.** Lifelong education and training for all Australians needs to prepare both young and old for new and different jobs and employment models. Automation, robotics and artificial intelligence are heightening the importance of skills in creativity, problem solving, advanced reasoning, complex judgement, social interaction and emotional intelligence. An objective for trainers and educators is to equip students with skills, knowledge and capabilities which are complementary to advanced artificial intelligence (not attempting to compete with it). Job tasks which are routine, repetitive, structured and rules-based are likely to be automated over coming decades. Training in specific tasks of this nature may hold lesser value than learning enduring concepts, knowledge and capabilities.

3. **Digital literacy is needed alongside numeracy and literacy.** To enter the labour market of the future Australians will need to be literate, numerate and digitally literate. These capabilities will be threshold requirements for most jobs. While numeracy and literacy have long been on the radar for education providers, digital literacy is a relative newcomer. A challenge is the rapid change in computer software and hardware, which can make learned skills redundant. However, there are likely to be fundamental and enduring concepts of digital literacy which will be important for future job seekers to have mastered. For example, skills in computer programming might become essential for a wide variety of jobs in tomorrow's knowledge economy. Identifying and teaching these enduring skills will be a priority for educators. Even traditionally labour-intense occupations like nursing or aged carer are likely to require an ability to work with computers and operate complex machines. A builder might as well need to understand and be able to connect the multiple devices and smart systems of future homes.

4. **The changing importance of STEM (whilst participation rates decline).** Science, technology, engineering and mathematics (STEM) skills are likely to be needed in many of the better-paid jobs of the future. As technology becomes more advanced and more complex, STEM capabilities may be an entry level requirement. However, recent research has revealed a gradual and long term decline in senior secondary school (year 12) participation rates in biology, chemistry, physics, intermediate mathematics and advanced mathematics in Australia [34]. There are questions about whether or not this decline is natural market forces at play, which should not be interrupted, or, whether there is a requirement for effort to bolster STEM capabilities within the current and future workforce of Australia. From some perspectives, improved computing technology and better user interfaces may reduce the need for technical capabilities, as devices become easier to use without technical skills. In general, however, STEM participation is in decline and there are good reasons to believe it will be increasingly important for getting a good job in the future for males as well as females.

Attitudes and perceptions are to be changed

5. **Aptitudes and mindsets to handle a dynamic labour market.** In tomorrow's job market adaptability, resilience, buoyancy and entrepreneurial capabilities are of growing importance. This is because of the increased pace of change fuelled by technological innovation and globalisation increases the need for workers to handle minor and major transitions. Workers will need the capability to handle a career dead-end (or job loss) and create their own job in another space. The character traits of a resilient individual represent aptitudes and mindsets which are learned over time and not easily built into a structured curriculum. However, these 'soft' skills may be increasingly vital for people to thrive in tomorrow's labour market.

6. **Challenging perceptions and norms about job types.** In Australia nine out of every 10 nurses are female and more than nine in 10 electricians are male. There are other professions with gender, age and cultural imbalances. These imbalances sometimes result from perceptions by employees and employers about the 'right' person for the job. Fluidity across boundaries and challenging perceptions will be increasingly important for full employment of Australia's workforce in the more dynamic and rapidly changing employment market of the future. Technology-enabled jobs may allow workers to cross industry boundaries with greater ease and reduce transition times from one job to another. For example, a change in mindset, accompanied with training, may see low skilled males working in manufacturing industries with workforce contraction move into caring professions (e.g. nurses, aged care) experiencing workforce growth.

Divergent and vulnerable demographics need attention

7. **Improving workforce participation in vulnerable demographics.** Finding positive ways to improve workforce participation rates for low skilled male workers is an increasingly important national priority. The number of working aged men not in the labour force has more than doubled since the late 1970s [23]. Non-participation in the workforce is likely to be associated with negative social outcomes (e.g. depression, stress, domestic violence) with community impact. However, the rising educational and skills requirements for many jobs, along with task automation in manufacturing (and other industries) are making conditions increasingly tough for this demographic. There is a requirement for solutions which help this demographic transition.

8. **Towards tapered retirement models**. There is a need to develop tapered (and other new) retirement models that productively harness the skills of an aged population and ensure positions are available for younger labour market entrants. In a tapered retirement model an employee gradually scales back and changes their duties rather than ceasing altogether. This could help unlock the productive value of knowledge and wisdom held by an ageing workforce while freeing up positions for a younger generation of workers eager to find a foothold on the lower rungs of the career ladder.

9. **New models to forecast job transition requirements.** The analysis of labour market transitions carried out by the Productivity Commission [48] shows how sequential pathways can be delineated for specific population groups and related to more or less successful labour market outcomes. However, to inform individual career choices in the fast-changing digital economy, more real-time and fine-grained modelling, drawing upon holistic and dynamic data will be required. Companies, industries, government agencies, regions, states/territories and nations need decision models which can:

   a. Predict existing jobs (and tasks) likely to be automated;

   b. Identify new jobs likely to be created; and

   c. Identify transition pathways via which individuals, organisations, industries and societies can make the switch as smoothly as possible.

New business models need understanding and adjustment

10. **Improved understanding of the peer-to-peer (and freelancer) economy.** This study identifies plausible scenarios via which the many – possibly most – Australian workers become portfolio workers and freelancers. This may create opportunities for companies to restructure their workforce and become more efficient. It may also create challenges and opportunities for employees who move towards these models. There are, as-yet-unanswered questions about how private and public sector organisations and individual employees connect with the newly arriving P2P labour markets:

    a. For what types of jobs, tasks and industries does a freelancer model work well and where does it not work?

    b. Should (and how should) companies transition from current arrangements to a more freelance workforce?

    c. How is fairness (for both employers and employees) ensured by government regulators within a freelancer workforce which may be delivering a large volume of micro-transactions across jurisdictional borders?

    d. What is the demand for offices and workspaces and what is the impact on the design and functioning of cities with a more agile, networked and connected population of portfolio workers?

BIO-RAD

1 INTRODUCTION

Getting and keeping a good job is one of the most important lifelong objectives for the vast majority of people across diverse geographies, cultures and demographics worldwide. A job allows individuals to participate in society, contribute to their community and generate income to support themselves and their dependants. For many people jobs are an important part of self-identity. People's working time consumes a large share of their waking hours: according to the World Health Organisation 58 per cent of the world's population spend a third of their adult life at work [49]. That means what happens at work matters for people's quality of life. Jobs and employment also matter for society as a whole. The productivity of the workforce drives economic growth and prosperity. It's unsurprising, therefore, that there is so much interest in the future of work.

This interest has been particularly intense in recent times. The past few years have seen numerous organisations commission and publish research on the topic of the future of work. They include the United Kingdom Government [50], the International Labour Organisation [51], the Massachusetts Institute of Technology Institute for Digital Economy [52], the University of Oxford Martin School [7], the Singapore Government Centre for Strategic Futures [53], the Foundation for Young Australians [54] and the Committee for the Economic Development of Australia [40]. Dedicated research centres have opened their doors, such as The Centre for the Future of Work at Carnegie Mellon University's Heinz College and The University of Sussex Future of Work Research Hub. The topic has featured heavily on the agenda of the World Economic Forum, the United Nations and the Organisation for Economic Cooperation and Development. The last year alone has seen countless conferences and meetings dedicated to the exploring the future of work. All this activity suggests that something is happening in labour markets now, and in the near future, that matters for social well-being and economy activity.

But why is now any different from before? In some ways nothing has changed. Jobs and employment models are continually changing with technology, demographic shifts, consumer preferences and social trends. They were reshaped through the industrial revolution, in the wake of the great depression and in the post-war years. As agriculture's share of the Australian economy declined in the 20th century, many farming jobs disappeared and new jobs, requiring new skills, were created in manufacturing, mining, and then service sector industries. There is nothing new about continual change in the types of jobs people do and how they are done. But because change happened in the past we should not assume there is no need to think about change in the future.

While change might be constant, so too is the need for strategic foresight and proactive planning to achieve better outcomes. Throughout history, governments, industries and society have made, and failed to make, important choices about how to re-skill and transition workforces into the future. One important difference about today's change is that we have the benefit of hindsight. Although it will present vast challenges, the rapid restructuring of labour markets in the decades ahead is neither unexpected nor unprecedented. Much has been learned about workforce transitions from the industrial revolution in the 19th Century [55] and the restructuring of the United Kingdom's manufacturing sector in the late 20th Century [56].

While there is much to learn from past disruptions, there are also reasons to believe that this time is different. We know more today than we did in the past and therefore have a better chance of achieving positive outcomes. Technology advances, digital connectivity, globalisation, the ageing population and the rise of new economic structures are creating a 'perfect storm' for jobs and employment models over the coming twenty years. In this report we argue that this period in history is witnessing a unique combination of forces that will lead to much more rapid transition and restructuring of labour markets in the near future than previously experienced. We identify three driving forces creating the perfect storm.

The first driving force relates to rapid advances in, and adoption of, digital technology. Compared with previous disruptive technologies such as electricity and telephones, the rate at which new digital technologies are being developed and adopted is much faster [57]. And while the internet, and its accompanying technologies have been a game changer for many industries, they may be yet to unleash their full disruptive potential. The majority of the world's citizens have not yet started using the internet. However, the number of users is growing rapidly. From 2000 to 2015 internet penetration grew sevenfold, from 6.5 per cent to 43 per cent of the world's population (400 million users to 3.2 billion users). Usage rates in developed economies are around 83 per cent of the population. As the developing world continues to close the gap, and as the world population grows, over a billion new online workers will join global labour markets over the next 20 years. Many will connect and work over mobile broadband, the most rapidly growing source of internet penetration, increasing 12 times since 2007 and showing signs of continued steep growth [58]. Unlike the industrial revolution, where geography limited the flows of products and labour, the information revolution has no geographical barriers. The new global internet-enabled workforce can deploy their skills, and compete with the local workforce, in just about any location.

Whether we look at device connectivity, computing power, data volumes, e-commerce, social media use and other indicators of digital technology growth (which are given detailed attention in the megatrends later in this report), we see steep or exponential growth both in terms of adoption and functionality. It is likely that labour markets, employment models and jobs will be significantly impacted by the digital economy beyond 2020. The effects may be greater than witnessed in recent history. For example, ten years ago there were six billion connected devices online. Today there are 15 billion. According to Intel, by 2020 there will be 200 billion connected devices [1]. This means that the next five years will see the number of connected devices increase by 13 times [1].

Given Metcalf's law, which states the functionality of a network is n^2 (where n is the number of connected devices), the internet of things will be 178 times more useful in only five years' time. This is obviously a crude approximation, but most of the opportunities and risks associated with the 'internet of things' are yet to transpire.

The second driving force behind the perfect storm is the shift in the institutional landscape associated with the rise of digital technologies. Digital native companies which utilise technology and capitalise on platform economics have demonstrated an ability to scale-up and disrupt markets more quickly than ever before. The taxi service Uber was created in 2009 and today has a market capitalisation of $US43 billion [59]. Facebook was incorporated in 2004 and today has a market capitalisation of $US305 billion [59]. Other platform economy companies, such as Google, eBay, AirBnB, Instagram and Amazon, have all achieved rates of market capitalisation much higher than historical patterns of company growth.

These companies also achieve this growth with fewer employees. Traditional retailer Walmart has a market capitalisation of $US265 billion and 2.2 million employees [59] – $US120 000 worth of market capitalisation per employee. The more recently emerged online platform retailer Amazon has a market capitalisation of $US173 billion and 154,100 employees [59]. This equates to $US1.1 million of market capitalisation per employee. Facebook's market capitalisation to employee ratio is $US22 million. This implies that technology companies can generate substantial value with relatively few employees. In general terms it would appear that fewer workers can achieve greater outcomes when they combine their skills with the power of modern information technology. This is the view of the American academic and economist Tyler Cowen in his book *The Average is Over* [60]. It is also why Erik Brynjolfsson and Andrew McAfee [52] conclude (good) jobs of the future come to those who learn to "race with the machine" not against it.

Another aspect of the digital landscape is the growth of the peer-to-peer economy and freelancer models. The websites Freelancer and Upwork, online platforms which allow employers to connect with employees for long and short term contracts, report substantial growth. Freelancer's most recent quarterly report [61] identifies 17 million registered users (employers and employees) and $AU4 billion worth of projects delivered. It also reports an increase in company cash receipts of 42 per cent and a 39 per cent year-on-year increase in users who post jobs (projects or contests). There is a plausible pathway via which freelancing becomes more commonplace in Australia's workforce. Apart from a rise in casual employment among younger workers, a major shift into a freelancing workforce is not (yet?) visible in employment statistics [62]. However, it may be that freelancing activity is not being captured by traditional employment surveys.

The theory of the firm, postulated by Nobel Laureate Ronald Coase, holds that firms arise because grouping employees together in hierarchical structures reduces transaction costs. Online platforms have the capacity for purchasers (employers) and providers (employees) to transact quickly, efficiently and with a clearer picture of the risks and rewards. This removes or reduces transaction costs and information asymmetries, meaning that in the digital era the firm might no longer be the most efficient means of organising labour. In summary there are strong reasons to believe the freelancer and portfolio worker will become a much more common model in tomorrow's labour market.

The third factor creating the perfect storm is demographic change. The megatrends in this report detail how Australia and the world's other developed and many developing economies are transitioning towards a more aged demographic. The spread from young to old in the workforce is likely to increase as retirement ages push back further. There will also be continued rises in diet- and lifestyle-related illness with impacts on the workforce. Mental health and wellbeing are also attracting more attention from employers and employees. These trends are showing steep rates of increase and are forecast to keep increasing for the decades ahead. For example, not until midway through the 21st Century will the rate of population ageing level off. Therefore, the major impacts of health and ageing trends will be expressed in the coming 20 years.

These drivers, combined with many other forces, are why today is different from the changes in jobs and employment models which have happened throughout history. This is why the issue of 'the future of work' is attracting so much attention from governments, companies, universities and communities. Another key difference is that today we are better informed as a society. We can learn from events of the past, and we have a much richer trends database. Economic theory tells us that eventually technology will create new and better jobs. This certainly happened in the industrial revolution of 1760 to 1850. However, it took considerable time for the benefits to materialise and they were not evenly distributed (Figure 1).

Figure 1 Real wages during (and after) the industrial revolution in Great Britain

Data source: Professor Charles Feinstein, The Journal of Economic History [55]

The industrial revolution saw the invention and widespread adoption of the steam engine, spinning wheels, cement, chemicals and many other technologies. These discoveries improved the productivity of industry. This eventually led to higher wages, higher employment rates and improved living standards; but it took a half-century for this to happen. A study [55] by Professor Charles Feinstein – an economic historian at the University of Oxford – finds that average real weekly earnings for workers in the United Kingdom increased at the rate of 0.4 per cent per annum over 75 years (1782 to 1857).

Other quality of life indicators reveal similar patterns of sluggish growth. From 1800 to 1860 the life expectancy (at birth) for the population in provincial cities (over 100,000 inhabitants) in England and Wales remained roughly constant at 41 years, and living standards actually declined for many of the new urban industrial workforce [63]. Not until after 1860 did life expectancy begin to rise, reaching 47 years by 1900, along with improvements in living standards.

Despite flat wages and poor conditions the effectiveness of the new machines meant change was inevitable. The Luddite movement, in which English workers smashed the factory machines which had reduced the value of their labour, was harshly put down. Eventually, however, the machines of the industrial revolution would create new jobs and better wages. Real wages in the period 1860-1880 (at the end of the industrial revolution) grew by 29 per cent or 1.4 per cent per year [55]. The period after 1860 also saw increasing life expectancies and improving living standards for the general population [63]. However, the people getting the new jobs and better wages were not necessarily those whose jobs had disappeared. This highlights the key challenge of technology-fuelled workforce transitions. Although technological progress delivers vast improvements in wages, lifestyles and overall quality of life, the costs and benefits are not evenly distributed over demographics, geographies or time periods.

Despite having happened a long time ago, the industrial revolution remains relevant to today's challenges. The information revolution currently happening in Australia and worldwide will see a significant transformation of the workforce, as did the industrial revolution. Both the types of jobs people do and the way employees are engaged by employers is likely to change substantially. The information revolution will not be limited to manual jobs. Its impacts will lie heavily, if not mostly, within the service sector industries that account for over two-thirds of the Australian economy.

This report describes the results of a strategic foresight project into jobs and employment in Australia from now out to 2035. Technology is a dominant theme, but the report also covers social, economic, environmental and political trends. The narrative of the future is told using the concepts of megatrends and scenarios. Megatrends are long term deep set trajectories of change. Scenarios are evidence-based stories about plausible futures. Multiple futures are always possible, because there is always uncertainty about how megatrends will unfold. Scenario planning is designed to enable multiple realities to be incorporated within a single story about the future.

The report commences with a brief description of the foresight methods and the current conditions of Australia's labour markets. This is followed by a description of the megatrends and scenarios for jobs and employment in Australia out to 2035. Next is a discussion of the issue of jobs replacement and job creation in a digital economy, as this has such a strong focus across the megatrends and scenarios. The final section briefly explores the implications for community, government and industry organisations.

The changes which lie ahead herald vast opportunities and challenges for current and future generations of Australian workers. Many jobs will disappear and many new jobs will be created. The implications of this report are that workforce transitions – how individuals move from one job to another and how industries move from one labour market structure to another – are crucial. While change is inevitable future destinations are not. Individuals, communities, companies and governments can identify and implement transition pathways based on this narrative of the future to achieve better outcomes.

2 A SNAPSHOT OF AUSTRALIA'S LABOUR MARKET TODAY

Australia has one of the most resilient economies in the OECD, with 23 consecutive years of economic growth and comparatively modest impacts from the Global Financial Crisis (GFC)[64], [65]. The underlying economy is dynamic, with over a million Australians changing jobs annually and businesses constantly entering and exiting the markets. Over the last decades, structural changes have seen declining employment in manufacturing and agriculture, while a far greater number of jobs have been created in the expanding service sector [40], [65]. There are 11.8 million people employed in Australia (6,377,000 men and 5,462,000 women) as at October 2015 [23]. The labour-intensive service industries are major employers, with healthcare and social assistance now the largest single industry, accounting for over 12 per cent of the total workforce [31], [40] (Table 1).

Table 1 Employed persons in Australia by industry division (main job, seasonally adjusted)

INDUSTRY	SHARE OF EMPLOYED
Health Care and Social Assistance	12.4%
Retail Trade	10.3%
Construction	8.9%
Professional, Scientific and Technical Services	8.8%
Education and Training	7.9%
Manufacturing	7.8%
Accommodation and Food Services	7.1%
Public Administration and Safety	6.3%
Transport, Postal and Warehousing	5.2%
Other Services	4.1%
Administrative and Support Services	3.5%
Wholesale Trade	3.3%
Financial and Insurance Services	3.3%
Agriculture, Forestry and Fishing	2.6%
Mining	2.0%
Arts and Recreation Services	2.0%
Rental, Hiring and Real Estate Services	1.8%
Information Media and Telecommunications	1.7%
Electricity, Gas, Water and Waste Services	1.2%

Data source: Australian Bureau of Statistics (ABS), *Labour Force, Australia August 2015* [66]

The recent mining boom has substantially affected the labour market. Between 2003 and 2013 mining industry employment increased more than threefold, though this still only equates to around 2 per cent of the workforce. The increased demand for labour in mining and related industries contributed to wage growth, which peaked at 6.7 per cent in 2008 [65]. Rapid growth in labour costs, coupled with slower growth in labour productivity [67] and a stronger Australian currency, reduced the competitiveness of Australian firms in the international market [65]. As the mining boom ends and the rate of technological change increases, the labour market in Australia is transitioning to the new models of employment.

2.1 Employment rates and spare capacity of labour

Australia has a relatively low unemployment rate by historical and international standards. However, over the last few years it has been growing, even while the EU, US and OECD unemployment rates have fallen (Figure 2).

Figure 2 Unemployment rate

Data source: OECD, Harmonised unemployment rate [68]

The rate of underemployment, the proportion of people who want to and can work more than they currently do (e.g. work part-time but are available for full-time work), is also rising (Figure 3). The labour underutilisation rate, which covers people who are unemployed and underemployed reached 14.3 per cent in August 2015 with a higher rate for females – 16.5 per cent [23]. This indicates growing spare capacity in the labour market [69].

Figure 3 Labour utilisation measures in Australia

Data source: ABS, Labour Force, Australia [23]

2.2 Youth unemployment

Labour market conditions for youth in Australia deteriorated significantly at the onset of the global financial crisis, and have only partially recovered since (Figure 4). For instance, while the youth unemployment rate has fallen, from a recent peak of 14.5 per cent in November 2014 to 12.2 per cent in October 2015, it remains well above the 8.8 per cent recorded in September 2008 at the onset of the global financial crisis and more than double the rate recorded for all persons.

Importantly, while most youth are either engaged in some form of work or study, a key concern is the number of young people who are 'disengaged' [70], with 358,100 (or 11.5 per cent of the youth population) not in work and not attending full-time education in October 2015, compared with 291,300 (or 9.9 per cent) in September 2008. While a proportion of the disengaged group may, for various reasons, be voluntarily outside the labour market (for instance, taking a gap year or looking after children, which is more likely to be the case for disengaged women), many are at risk of ultimately failing to make a successful transition to employment.

That said, it is encouraging that the proportion of youth participating in full-time education has increased significantly over the period, from 47.2 per cent in September 2008, to 52.0 per cent in October 2015 (equating to 237,500 additional youth in full-time education) as increasing educational attainment can improve the labour market prospects of young people.

Youth unemployment and failure to find the first job have been shown to have 'scarring' effects on those entering the job market, with potentially lasting negative effects on health and career prospects [71], [72]. Unemployment early in life is associated with a higher risk of being unemployed or discouraged from looking for work in the future, as well as lower earnings than peers [72], [73], especially among low skilled workers [74]. As a result, the current issues of youth unemployment in Australia may have a long-term impact.

Figure 4 Unemployment rate: general population and youth in Australia

Data source: [23]

Automation of low-skilled, routine jobs with low barriers to entry might also be contributing to the decreasing employment opportunities for youth. McDonalds cashier jobs, for example, an entry level job for school leavers, are set to decline due to the introduction of self-service kiosks [75].

2.3 Earnings

Australians have been enjoying one of the world's highest wages for decades (Figure 5). Weekly wages in many industries, including mining, professional services, finance and construction, more than doubled over the last 20 years [76].

Figure 5 Average annual wage in Australia and G7 countries
Data source: OECD, *OECD. Stat* [77]

International research suggests that labour markets are polarising [78], [79], with more workers moving into higher and lower skilled jobs compared with mid-level jobs [80] More skilled workers enjoy an increasing wage advantage, while the real earnings of low skilled workers are declining and the routine tasks of former mid-level workers are being automated A concept of skill-biased technical change also suggests that the new information technology might be favouring skilled over unskilled labour, offering complementarity between technology and skilled workers and increasing the productivity of the latter [81], [82].

Australia shows no clear evidence of workforce polarisation [83], but it may become apparent as technology makes more inroads into workplaces. However, what is observed in Australia is that at the household level the number of jobless families is increasing [84]. The proportion of children under 14 year old living in jobless households in Australia in 2011 reached 14 per cent, the fourth-highest rate among OECD countries [85].

2.4 Skilled labour – Australia's competitive advantage

A highly educated workforce is one of the cornerstones of the Australian economy. Tertiary level education rates have grown each year since 2001 [86] and are well above the OECD average.

However, the global talent pool is currently growing rapidly as more people in less developed countries such as India and China enter tertiary education [37]. This indicates increasing international competition in the skilled labour market, and means it is unclear whether the growing number of educated people around the world will continue to enjoy earning premiums and better career perspectives [37].

2.5 Climate change and employment

Climate change is impacting Australia, and will continue to do so in many ways, including increasing average temperatures, number and length of heat waves, extreme weather events and sea level rise [87]. Since 1910 the average air temperature in Australia has increased by 0.9°C, and it will climb further over the next 20 years [88]. This has significant implications for the environment and associated industries such as agriculture and tourism [89]. Climate also affects worker productivity – international studies find that each degree of temperature increase above 25°C is associated with a 2-7 per cent productivity loss [90], [91]. Given our already hot climate, this is concerning for Australia. Those doing outdoor physical work will clearly be most affected, with more hot days bringing greater health risks, particularly for older workers [92], [93]. It is likely that industries such as construction will have to modify their work practices to mitigate these risks.

3 STRATEGIC FORESIGHT

3.1 Strategic foresight method

Strategic foresight is an emerging research field and profession which aims to explore plausible futures and help people make wiser choices. It occurs at the intersection of multiple disciplines including geography, economics, management science, operations research and planning theory. The field of strategic foresight attracts regular conferences, university courses and dedicated research and professional journals.

Concepts of strategic foresight emerged after World War II, with an early focus on technology forecasting. In the 1960s and 1970s the field was given a boost by the formation of the Royal Dutch Shell (an energy company) scenario planning team. Over the decades that followed, thousands of scholarly articles, professional guides and books have been published on methods and applications of strategic foresight. Cutting edge research is developing processes via which future scenarios can be combined with decision theory to select optimal strategies.

Over the past seven years CSIRO has developed a generic strategic foresight process (Figure 6) pioneered through multiple megatrends, scenario planning and strategy projects delivered in diverse industry sectors. It draws upon numerous theories developed by researchers worldwide and on CSIRO's own practical experience in delivering many strategic foresight projects to private and public sector clients. This process for identifying megatrends and scenarios has been applied in the current study. There are five main phases of strategic foresight using this process.

In the first stage the process involves a background study and scope definition. The background study documents the current conditions, size, structure, opportunities and challenges within the industry, region or societal grouping being studied. Unlike the succeeding stages, the background study is concerned with the current status and historic conditions. It does not attempt to look into the future. The scope defines the stakeholder groups, timeframe and issues to be considered throughout the remainder of the project.

WHAT ARE MEGATRENDS AND SCENARIOS?

Megatrends are gradual and deep-set trajectories of change that will at some point reshape the business and policy environments. They typically have a decadal time frame (e.g. 5-20 years) and occur at the intersection of multiple trends. Trends are more specific patterns of change which typically have shorter duration and relate to specific geographies or issues. The term megatrend was introduced by US economist and academic John Naisbitt [307] in his 1982 book of the same title, and is today used widely in foresight studies. In our approach megatrends are shown using an overlapping Venn diagram to illustrate the connections. A scenario is an evidence-based and plausible narrative about the future at a set point in time. Scenarios represent an estimation about how the megatrends unfold, based on best available data. Because the future is uncertain there are multiple plausible scenarios. In our approach scenarios are created by axes – continuums of uncertainty and impact associated with the megatrends. Two axes will create four quadrants and four scenarios.

In the second stage trends are identified using a horizon scanning process. This casts a wide net over all patterns of change that are potentially relevant to the issue at hand. The environmental scan errs on the side of being overly inclusive rather than exclusive. The trends are typically grouped as geopolitical, social, economic, environmental and technological. However, an alternative and tailored nomenclature can be designed to classify the trends based on the unique needs of the study.

Processes of validation and screening are used at a secondary stage to remove any 'by-catch' – trends which are unsubstantiated or irrelevant. The screening and validation process ensures that trends pass two tests: (1) evidence that the pattern of change is actually occurring and likely to continue occurring into the future and; (2) evidence that it matters to the issue. The process of validation often involves checking the proposed trend against datasets, expert opinions and research findings published in journals to ensure accuracy. Sometimes there is evidence that both supports and undermines the trend.

Figure 6 Generic foresight process developed by CSIRO

The foresight team needs to make a difficult judgement call about where the weight of evidence lies and whether the trend should be included.

In the third stage the trends are collated and synthesised to identify more salient patterns of change and possible future events that have significant implications for decision makers. These are captured as building blocks – scenarios, megatrends and megashocks. These building blocks are not necessarily mutually exclusive, and a foresight study may use one, some or all in developing a narrative about the future.

The final two stages involve crafting and communicating a narrative about the future and then injecting that narrative into strategic decision-making processes. The narrative captures all of the relevant building blocks and describes the methods and information sources so that the audience can have confidence in the results.

3.2 Expert interview outcomes

Interviews with key experts were designed to help inform and validate the megatrends and scenarios. The information collated from the interview process was reported back to the CSIRO Futures team who were concurrently conducting the horizon scanning process.

Ten interviews were undertaken with representatives from federal government departments, universities, independent review and advisory bodies, national associations, peak bodies and various non-government organisations relevant to the future of work. Some interviews were one-on-one, others used a lead interviewer, but with multiple project team members listening, and on occasion asking additional clarifying questions. The interviews were conversational in style, and took between 30 and 60 minutes to complete.

The interviews took place either via telephone or face-to-face, using the convergent interviewing technique developed by the University of Queensland [94], [95]. Convergent interviewing aims to collect, analyse and interpret people's experiences, opinions, attitudes, beliefs and knowledge that converge around a set of interviews. Using this technique, interviewers engage in a constant-comparative reflexive process that permits detailed rich content and theoretical sampling as researchers seek to continuously test emerging interpretations from early interviews in subsequent interviews. This process provides rigour and structure to the analysis despite the reliance on unstructured content. This technique involves a series of interviews. The interpretation of data converges over the course of the series. As the interviews go on, constructions of the question at hand become more rigorous and detailed. Every interview, moves from open-ended to focussed, with convergence also occurring within the interview itself, through the use of probe questions that become progressively more detailed and specific. From interview to interview, these probe questions involve the interviewees in interpreting the data. Participants are encouraged to challenge, change or confirm, interpretations and theories emerging from the interviews.

A suitable opening question in convergent interviews is one that encourages interviewees to talk about the strengths and weaknesses of the current issue. The interview in this instance opened with the question, "What are the key trends that you can see emerging that will influence the future of work over the coming twenty years – so out to 2035?" The interviewer purposely did not contribute content to the conversation, using only prompting questions to continue the conversation, or on occasion using questions to validate points from previous interviews.

In addition to interviews with individual experts, two focus group workshops were conducted with a mix of federal government agencies, adapting the interview protocol to make it suitable for a focus group environment. A summary of the trends identified by interviews and focus group workshops is captured in Table 2.

Following on from these interviews, two half-day workshops were held in Canberra with approximately 70 additional experts, to refine the formative megatrends and scenarios. Workshop attendees actively participated in the process and provided a wealth of data to contribute toward refining of the megatrends and scenarios presented in this report. Both the interviews and workshop were conducted in accordance with CSIRO Social Science Human Research Ethics Committee approval.

Table 2 Trends identified by interviewees and focus group workshop participants

CATEGORY	OBSERVED TREND
Geopolitical	Globalisation
	Population growth
	Migration
	Mobility of labour
	Intergenerational disadvantage
	Terrorism
	Offshoring of jobs
	Income distribution – inequity; precarious employment; unstable employment
	Focus/role/structure of education system; continuous learning; MOOCs
	Gender equity
	The governance of employment; the role of unions
	Age of voting population
Economic	Participation rates
	Youth unemployment
	Wage rates
	Self-employment; entrepreneurs
	Business structures; vertically integrated firms; small micro-multinationals; global value chains
	Taxation
Environmental	Urbanisation; redesigning cities; decentralisation
	Climate change
	Green/clean energy; renewables vs. fossil fuels; transition to a 'green' economy
	Water; desalination/manufactured water
Social	Ageing population
	Re-designed/flexible work arrangements; boundary-less; freelancing;
	Open/flexible working spaces; activity based operating environments
	Non skilled vs. skilled workers; EQ vs IQ; STEM skills
	Mental health
	Value on quality/niche/individualised products; service design; customer experience
	Social services/protection systems i.e. pensions, health
	Human factor; face-to-face contact
Technological	Digitisation
	Automation and job substitution; replaced vs. redefined vs. new
	How people communicate – social media; privacy
	Online services; personalisation; flexibility
	Big data; integrated systems; analysis and interpretations; data mining
	Advanced manufacturing
	Robotics; AI, 3D printing; driverless cars; super computers; 'Watson'; telepresence

4 THE MEGATRENDS

4.1 The second half of the chessboard

The explosion in device connectivity, data volumes and computing speed, combined with rapid advances in automated systems and artificial intelligence, means that robotic devices and other computational systems can perform many tasks quicker, more safely and more efficiently than humans. The growth in technological capabilities is transforming supply chains, reshaping the workforce and redefining jobs. The challenging prospect is that the growth is not linear (constant) but rather exponential. As we move beyond 2020 (and into the second half of the chessboard) things may start to transform rapidly.

Computer power is increasing exponentially. In 1965 Gordon Moore, co-founder of Intel, predicted that the number of transistors on computer processors would double yearly and that this growth rate would continue for another decade [96]. In 1975 he revised this figure to doubling every two years, a prediction holding steady today[97], [98] (Figure 7). This prediction, Moore's Law, came to serve as a goal for the industry. A prime example of Moore's Law is the exponential increase in Intel processors, apparent in the processing speed and memory of todays' smartphones compared with those of the Apollo Guidance Computer used in every Apollo mission [2]. Moore's law will hold true for as long as new ways can be found to push existing technology to its limits. When the era of Moore's Law inevitably ends, it will not necessarily mean the end of extraordinary innovation or life changing computing technology, but rather perhaps a shift in focus or direction for technological advancement, or more incremental changes and improvements. In addition to the exponential growth of computer power, there has been a significant decrease in its cost [99]. This declining cost is of great relevance to the economy, and to the global accessibility and availability of technology, which is likely to complement workers in the future.

Figure 7 Number of transistors on an integrated circuit at the same cost (Moore's Law)

Data source: Intel [98]

The 'Internet of Things' (IoT) industry is rapidly growing. IoT is one of the most significant technology trends happening as we speak. According to Intel, an anticipated 200 billion smart devices will be in use by 2020, compared with two billion in 2006 and 15 billion today [1]. Although predictions on the number of Internet connected devices vary significantly (20.8 billion devices by 2020 according to Gartner Inc. [100]; CISCO estimate – 50 billion connected devices [101]), the potential to offer advanced connectivity allowing for detailed data collection and collation is extraordinary. Devices incorporated into the IoT are numerous and varied, including vehicles with inbuilt sensors, heart monitoring implants and mobile phones. Currently, most IoT devices are not found in homes, but rather in businesses, factories, production facilities and within the healthcare industry. This is primarily due to the capabilities of smart devices to provide data which enable industries to accurately track inventory, manage various machines, increase efficiency, increase cost effectiveness and potentially save lives. It is estimated that by 2025, the total global value of IoT technology will be $US6.2 trillion, the vast majority from health care devices ($2.5 trillion) and manufacturing ($2.3 trillion) [102]. While most devices in the IoT currently focus on supply chains, machine and system performance, and business applications rather than individuals and consumers, this is changing – allowing for a more connected world as a whole, and opening up a vast array of potential opportunities for businesses and individuals alike.

The global growth of internet connected devices is transforming the way in which people live and work. The competitive, innovative nature of the technology sector inspires and stimulates novel developments in smart device functionality. They allow businesses to work more efficiently, develop new products and services, and expand their market reach. Millions of jobs have been created as a result of this growth, within a whole new, unique universe of connectivity and opportunity [103]. However, with these innovative advancements come some difficulties. Every single device connected to the internet possesses a unique IP address. Originally, IPv4 provided the capability for 4.3 billion devices to be connected to the internet simultaneously [104]. However, there are already more devices than there are IPv4 addresses – a situation predicted a number of years ago. With the explosion of the IoT and the exponential growth in numbers of internet connected devices, IPv6 was developed – allowing for 340 billion-billion-billion-billion new unique IPs. The transition from an IPv4 environment to an IPv6 environment is a slow but steady process, but in the three years since its global launch, IPv6 connectivity has more than tripled with Google users, and is expected to become the dominant protocol by 2018/2019 [105]. This will allow every person worldwide to have multiple addresses for every device they own, providing opportunities previously considered inaccessible.

Social media offers new ways to connect as well as a need for big data analysts. Social media has rapidly become a popular and efficient platform for sharing, communicating, networking and collaborating for individuals, organisations and businesses globally. The number of Australians accessing social media at least once per day has jumped from 30 per cent to 50 per cent over the past five years [106] (Figure 8). However, the power of social media reaches far beyond the ability to provide alerts, warnings, real-time information and to share images and diagrams. It provides opportunities for employers and potential employees to access entirely new employment environments previously considered beyond reach, with 93 per cent of recruiters using, or planning to use social media for recruitment [107]. Social media also offers businesses increased brand awareness, enhanced customer analytics, and new sales channels [108].

Additionally, the once separate domains of professionals such as journalists, scientists, business owners and the general public are increasingly becoming more and more interconnected, with social media enabling immediate and significant connections – connections that may previously have been considered beyond conventional reach. An excellent example of such interconnectedness is LinkedIn – a platform focusing exclusively on professional networking, with members frequently utilising it to recruit potential employees or actively seek employment. With over 400 million LinkedIn users, the potential for access to numerous general and niche employment markets is considerable [109].

Figure 8 Social media use in Australia

Data source: Sensis Social Media Report [106]

Australia has high rates of internet access and mobile connectedness. Mobile phones and internet devices have become a significant and important aspect of Australia's communication environment. Australia is ranked fourth in the world for active mobile broadband subscriptions per 100 inhabitants, and internet access via mobile phone more than tripled between 2010 and 2013 [2]. However, while the ability of tablets to take computing and internet access to an entirely new level is important, it is the smartphone which will most likely have the greatest impact in providing internet access to everyone, due to their decreasing cost and increasing power and connectedness [110], [111]. In May 2014, 12.07 million Australian adults (74 per cent) were estimated to be using smart phones compared with 11.19 million (64 per cent) in May 2013 [112]. The extent to which mobile devices

have become substitutes for traditional, fixed phone lines and internet is apparent when observing that mobile broadband subscriptions, including mobile handsets and wireless dongles, have reached parity with traditional fixed broadband subscriptions over the past five years [5] (Figure 9). In December 2014, 12 per cent of Australian adults had neither a fixed-line telephone nor fixed internet in their homes, instead relying solely on smart phones and mobile devices [3]. This effect is potentially due to a combination of factors, such as availability, affordability and increased functionality of mobile devices. These have rapidly become an integral part of everyday life for numerous people, with many embracing them as an 'everything hub'. Essentially, the technology offers access to a whole new world of connectivity that is on 24/7 and that in itself is changing the way people work and live day-to-day.

Figure 9 Australian Internet subscriptions

Data source: ABS, Internet Activity [5]

Internet access is growing globally. Growth in the uptake of information communication technology (ICT) has continued steadily worldwide over the last five years. In 2014 the number of fixed-broadband subscriptions reached a total of 711 million globally, equivalent to a 10 per cent penetration rate, compared with the 2005 figures of 220 million subscriptions and a 3.4 per cent penetration rate[2]. The mobile broadband market has exhibited the most rapid progress, maintaining double-digit growth rates in 2014 and a projected global penetration rate of 32 per cent – four times that of 2009 [2]. On a global scale, Australia's internet penetration is ahead of regional averages, though penetration has increased across all regions – with the ex-Soviet Commonwealth of Independent States countries showing the fastest growth in recent times [113]. Mobile broadband and internet access has the most rapid growth in developing countries. However, the divide between developed and developing countries remains vast, with mobile-broadband penetration reaching 84 per cent in the former, and only 21 per cent in the latter [2]. These digital divides need to be addressed in order to ensure that as many people as possible are able to access affordable, efficient mobile communication networks, and the associated development opportunities, including employment.

Data growth is fast. Internet data usage in Australia is growing at an exponential rate, with the volume of data downloaded by fixed line broadband showing a 35 per cent increase in the twelve months to December 2014 [5] (Figure 10). By December 2035, a predicted 15 billion terabytes of data will be downloaded semi-annually [5]. However, with the rise of high definition streaming, this extrapolation may be a significant underestimation. Roughly 2.5 exabytes of data will be generated on any given day in 2015, more data than was generated in total since the dawn of time until 2004 [4]. Globally, the volume of data downloaded has increased from 130 to 7910 exabytes in the last decade [114].

Figure 10 Terabytes of data downloaded using fixed line broadband in Australia

Data source: ABS, Internet activity [5]

Big data faces explosion and requires data analysts. The escalation in global connectivity and networking is generating significant amounts of data at an ever-increasing rate, with considerable impact on day-to-day living. Exploited in the right way, big data can be of great benefit to individuals and organisations – offering insight into a multitude of areas such as smarter cities, faster medical breakthroughs, more efficient use of resources and employment demands [115]. Organisations are already embracing big data – becoming more data driven in their decision making, product and service development, and in their interactions with customers, employees, suppliers and stakeholders. A prime example is social media, which is changing the way marketers approach their customers, and also adding complexity to the marketing process. According to a recent IBM study of more than 17,000 chief marketing officers, working in 19 industries in 64 countries, the top challenge is the explosive volume, variety and velocity of data from new digital sources such as social media and networks (71 per cent), followed by social media marketing (68 per cent) and the growth of channels and device choices (65 per cent) [116]. It is important to note that, with the continually increasing volume of data being generated, there will be a gap in the skills and ability to utilise it to its full potential. McKinsey estimates that the US alone faces a shortage of 140,000 to 190,000 people with the required analytical expertise [6], providing opportunities for the creation of multiple data-related IT jobs.

Rapid advances in artificial intelligence (AI) There are a number of excellent examples of automation and AI advancements that test the boundaries of human-robot interaction with positive results: IBM Watson – a cognitive computer system capable of answering questions posed in natural language [33]; the Battlefield Extraction Assist Robot (BEAR), designed to locate, lift and carry wounded soldiers out of harm's way without risking additional lives [117]; driverless or self-driving cars – predicted to be on-sale by 2020 [118]; the Henn-na Hotel, Japan – the famous robot hotel with various types of automated receptionists, robot porters and facial recognition[119].

Some jobs face a risk of computerisation. The green revolution in the US saw technology-induced productivity rises in agriculture shift the labour market [120]. In the early 1800s, 70 per cent of jobs were in agriculture, by 2010, only 2 per cent were [121], [122]. It is anticipated that computerisation will affect many low-skill jobs similarly, with computer-guided automation becoming increasingly prevalent across numerous industries and environments including manufacturing, planning and decision-making. Frey and Osborne famously analysed how susceptible jobs are to computerisation as we progress through an era of rapid IT development [7]. They determined that on aggregate, lower paying jobs with lower formal education requirements are most at risk of computerisation. However, technology is also creating many new jobs, both through increasing the productivity of existing industries and the development of entirely new industries. This issue is covered in more detail in section six of the report.

4.2 Porous boundaries

Digital technology and the new world of 'platform economics' is changing employment markets and organisational structures. The peer-to-peer economy is expanding into many areas and, while freelancing has not yet taken hold in Australia, it is a large (and growing) employment model in other countries. Companies may opt for staffing models which include a smaller number of core staff, with many other roles provided by the freelancer or portfolio worker community. Jobs of the future are likely to be more flexible, agile, networked and connected.

Globalisation is not a new phenomenon. The interaction of individuals and communities across long distances, the emergence of an international network of economic systems, and the removal of borders for the international expansion of markets are not new concepts [123]. However, in recent decades the rate of globalisation has increased, in part due to the development of improved technologies [124], [125]. Technologies such as the internet and advances in global communication may be considered to be both a product and catalyst of globalisation, and have influenced the acceleration of the interdependence of companies and countries globally – with significant impacts. Additionally, we now have a more mobile population, with the global movement of people steadily increasing over the last sixty years [126] (Figure 11). Once considered a luxury, international travel is now considered a part of everyday life for many. People, companies and countries are less restricted by borders or distance, and consequently, the world is a more connected, interactive place. Essentially the world is developing into one large market, including labour markets, rather than a series of separate national markets – providing access to previously unreachable opportunities in business and employment.

Figure 11 Millions of inbound passengers in Australia

Data source: ABS, Overseas arrivals and departures [126]

Cloud computing has arrived. 'The Cloud' is a unique business and technical model for enabling ubiquitous, convenient, on demand access to a shared pool of computing resources. The Cloud assists businesses to overcome economical, technical and geographical limitations, and offers a multitude of benefits – agile systems and environments, reduced costs, device and location independence, low maintenance, multi-tenancy, enhanced performance monitoring, increased productivity, reliability, scalability and elasticity, security [127]. The potential for geographically diverse groups of workers to collaborate and share files, data, information etc., and the ability for businesses and workers to utilise fluid workspaces, flexible working arrangements, and co-working environments are extraordinary. Such flexible work environments promote and enable greater collaboration, increased outsourcing and offshoring of work, and superior specialisation capabilities. The era of cloud computing will allow businesses and companies to have smaller departments that will be able to quickly analyse data, experiment endlessly and embrace the new technology to be more data-driven. The potential impact of cloud computing on employment and the workforce is indicated as being primarily positive, with recent reports showing that, rather than eliminating corporate IT jobs, cloud computing is offering IT professionals opportunities for reskilling, upskilling and career advancement [128], [129]. It also brings new problems which will require solutions – for example in fields of privacy and security.

Peer-to-peer (P2P) employment market is rapidly emerging. The employment market of today is markedly different from that of the past, with a high reliance on technology and the internet. Sites such as Upwork, Kaggle, InnoCentive and Freelancer.com allow both employers and potential employees to advertise employment opportunities, promote themselves and access job markets that otherwise would not be readily accessible [14], [15]. The P2P market allows people to offer a great range of services, and means that even minor tasks can be efficiently outsourced to the market, both during and outside of regular business hours. P2P services such as Airbnb, Uber and PPost successfully provide value through convenience, low barriers to entry and increased speed and efficiency. P2P sites Etsy, Madeit and Handmade Australia enable people to transform their free time into paid work – either as additional or sole income. With competition increasing and P2P networks expanding locally and globally, we will soon see all manner of small businesses and services appear. This is anticipated to be a positive development, as the increasing popularity of P2P sites and services benefits businesses, consumers and the economy, and is a great solution for a sluggish employment market.

Flat organisational structures. Flatter organisations typically have minimal management levels and offer more teamwork, less bureaucracy, better communications, opportunities for professional development and greater job satisfaction [130]. Rather than escalating responsibility up the management ladder, flat structures empower employees to take control, help make decisions and feel responsible for the company's successes. With fewer levels of management, companies with a flat organisational structure tend to have short lines of communication, enabling the company to make decisions quickly and be fairly responsive to change. Essentially, a flat organisation oversees workers less and promotes their increased involvement in the decision making process within the business. Studies have determined that, within a number of Fortune 500 companies in particular, there has been a significant increase in the number of positions that answer directly to the CEO, in part due to the growing incidence of functional specialists at the executive level [131]–[133]. Flat organisational structures are being applied by start-ups and both small and large businesses to bolster innovation and productivity. For example, the US Defence Advanced Research Projects Agency (DARPA) has only one level of management between the research program managers and the director, allowing ideas to flow quickly [134].

The growing population of portfolio workers. A portfolio worker is a freelancer who provides services to multiple employers. Facilitated by digital technology, labour is becoming mobile and independent. The independent sector is growing, broadening and getting younger [135] worldwide. Nearly one in three working Americans is an independent worker [8], [9]. Freelancer.com is the biggest platform for freelancing labour market, and now connects over 17 million employers across 247 countries [10] with over eight million projects posted. The number of users has grown from one million in September 2009 to 10 million users in January 2014 (Figure 12). While typically not captured by existing employment statistics [136] (the number of independent contractors in Australia is reported to have been around 1 million both in 2009 [137] and in 2014 [138]), the growth and popularity of the freelancer workforce shows little sign of slowing, with 32 per cent of freelancers reporting an increase in demand for their services. One survey found 88 per cent would continue with freelancing even if they were offered a traditional full-time position [11]. Freelancing has its challenges, such as lack of stable income and difficulty finding work – but advances in technology and more globally connected environments are drastically changing these dynamics.

Figure 12 Number of co-working spaces and Freelancer.com users worldwide

Data source: Freelancer.com [10]; Deskmag, *Global Co-working Survey* [12]

Co-working facilities are expected to double. The workplace is evolving in both its functionality and appearance. This evolution has created co-working – a style of work environment that combines a shared work space such as an office, with independent activity of workers who are usually not employed by the same company [139]. Co-working is generally appealing to work-from-home professionals, independent contractors and frequent travellers who typically end up working in relative isolation [140]. Such is the popularity of co-working that there has been a rapid increase in the number and variety of co-working spaces established globally, with studies showing that seats and spaces have roughly doubled each year since 2006 [141] (Figure 12). In 2012 the number of co-working spaces in Australia increased by 156 per cent [12]. The benefits of such fluid work spaces are many: reducing costs for and encouraging the establishment of start-ups and small companies, opening up opportunities for the use of underutilised space, the development of communities, and potential for mentoring and business development guidance. Flexibility of working arrangements is therefore likely to become a sought-after attribute for potential job seekers. An increasingly mobile and geographically distributed staff might require new approaches to the human resource management of organisations in the future.

The horizon for office leasing is getting disrupted. With recent increases in co-working, start-ups and freelancers, there is a real need for fluid, flexible, hassle free workspaces, and demand is increasing. The traditional office cubicle and associated tenancy agreements and fees are rapidly becoming a thing of the past – downsizing of allocated office space is on the rise, and utilisation of shared, productive space is being maximised. It is anticipated that Brisbane's CBD office vacancy will peak at 18.4 per cent by January 2017, as compared to Sydney (7 per cent) and Melbourne (8.5 per cent) [13] The number of businesses taking advantage of this demand for a new style of workspace is also increasing. Liquid Space and Space & Co are two Australian start-ups that are prime examples of networks successfully connecting people with the flexible workspaces they require. Another highly successful example is WeWork – an American start-up embracing and marketing this new type of work space lease. They provide shared workspaces, community and services for freelancers, start-ups, entrepreneurs and small businesses. The company predicts that by the end of 2015 it will double its current number of workspaces globally, from 29 to 60. and it is currently worth over $5 billion [142], [143]. With the popularity and growth in demand for flexible work environments showing little sign of slowing, it seems that this new style of leasing and renting will continue to be in demand.

Dissolving barriers to new business entrants. Barriers to market entry act as a deterrent against new businesses and competitors, and can be either unintentional or deliberate. They are recognised as being one of the five forces that determine the intensity of competition within industry – as per Porter's Five Forces [144]. Traditionally, these barriers would be considered reasonably effective as a defensive mechanism. However, advances in technology over the last few years, increased global connectedness and the subsequent growth in the independent and peer-to-peer markets have all had a significant impact on the way businesses operate. Consequently, limitations and barriers preventing market entry of start-ups and new businesses are rapidly becoming null and void in many instances. Online markets allow small businesses and start-ups to exploit low entry barriers such as low initial capital investment requirements, easy access to marketing and distribution channels, and no relevant advantage due to location. Prime examples of such instances include Uber – the world's largest transport network/taxi company that doesn't own a taxi; and Airbnb – the world's largest accommodation/hotel chain that doesn't own a hotel [145], [146]. The removal of barriers allows for innovative and unique business ideas to actualise, with an enticingly small amount of risk involved.

4.3 The era of the entrepreneur

The ideal job within a large organisation may not be awaiting an increasing number of future job seekers. This means they will need to create their own job. This will require entrepreneurial skills and aptitudes. Digital technology works to the advantage of tomorrow's entrepreneur. Digitally enabled models of lean innovation (the fast fail approach) operate at low cost and scale-up rapidly. Digital provides options for new market entrants to gain a foothold and compete with longstanding incumbents and access a global market. Entrepreneurial skills are likely to be increasingly important for small business founders and employees within large organisations.

Small business demonstrated rapid growth pre-GFC, but flattened post-GFC. With small business considered to be the driver of the economy, encouraging growth and innovation, and offering millions of job opportunities, the growth of the small business environment is of great importance to the Australian economic environment. Prior to the GFC, the small business environment in Australia was considered to be internationally competitive and productive. The rapid growth of small business in the lead up to the GFC is evident: in 2006-07 there was a 35 per cent growth in the number of small businesses employing 1-4 people compared with 2003-04 [16], [17] (Figure 13). These increases may be attributed to a number of factors, such as lower interest rates, more easily accessible credit, and increased consumer spending and low staff turnover – all of which also contribute to decreased perceived risk for start-ups and small businesses.

Figure 13 Small business growth pre-GFC

Data source: ABS, Counts of Australian Businesses [17]

While it seems that Australia generally escaped the GFC relatively unscathed, many small businesses felt the impact acutely. This can be attributed to a number of factors, including higher interest rates for small business loans relative to other loan types, difficulty obtaining credit, reduced consumer spending, staffing cuts and staff turnover. The post-GFC growth in small business numbers decreased dramatically – though Australia still fared better than the US, where the number of firms employing 1-4 people fell by four per cent in the four years post-GFC [17], [18], [147]. Essentially, many small businesses had to minimise resources, staffing levels and expenses in order to ride out the GFC – tactics that may have left them unable to take advantage of gradually improving post-GFC conditions.

Employment and wages in small business are shrinking in Australia. In Australia, small businesses account for the largest proportion of employment. However, post-GFC, that proportion has declined, with total employment in the small business environment falling from 47 per cent in 2008-2009 to 43 per cent in 2012-2013 [17], [18] (Figure 14). While the GFC economic downturn is not solely responsible for the move away from employment within small businesses, it has contributed to some extent - particularly through the flat growth of small businesses post-GFC [148]. In addition to this, other contributing factors may include the differences in employment growth rate between small businesses and big businesses, and the potential that big businesses are becoming more successful at preserving jobs and retaining workers [148]. Additionally, in Australia, small business has fallen to last place for total wages paid since the GFC [18] (Figure 15). Despite the lack of small business growth, the survival rates for small businesses have slightly improved since the GFC [17]. This shows that the decline in small business growth has been driven by a reduction in new firms entering the market.

Figure 14 Proportion of employees by business size

Data source: ABS, Australian industry [18]

Figure 15 Proportion of total wages paid by small business

Data source: ABS, Australian industry [18]

Small businesses have a growing potential ahead. Over the last decade, digital technology has transformed the scope, scale and potential of business, disrupted traditional business models, and fundamentally changed the behaviour of the customer. Advances in digital technology allow even the smallest of businesses to build reputations and access large markets. Technology also lowers barriers to entry for start-ups and allows opportunities to experiment with new business models. However, deciding on precisely how to make the most of the multitude of digital opportunities can seem overwhelming and complex. Subsequently, many businesses fail to investigate and scrutinise the available opportunities or opt to employ a 'wait and see' approach, neither of which are realistic in today's competitive climate. PwC estimate that businesses can unlock an additional $49.2 billion in the private sector over the next decade if technologies are used to their full potential [149] (Figure 16). A larger, better-connected economy also offers more niches to exploit – sites and networks such as Etsy, eBay, LinkedIn and Amazon.com allow small businesses to sell their services and wares without much outlay or risk. The growth and far-reaching impact of the digital age offers innovative opportunities to create new sources of value, new markets, new niches and a new breed of workers.

Figure 16 Potential additional income for small businesses over the next decade

Data source: PwC [149]

Australia offers an environment conducive to entrepreneurship. Enterprise and entrepreneurs are the driving force behind a significant portion of the innovation, productivity growth and new employment opportunities in today's business environment, and are key factors in economic growth. In 2013, Ernst and Young named Australia as having one of the world's top five entrepreneurial ecosystems, as determined by measurements of five key elements: access to funding, entrepreneurship culture, tax and regulation, education and training, and coordinated support between the public, private and voluntary sectors [19]. They attributed it in part to the adoption and success of new work practices and environments – including the growth of co-working spaces, flexible work contracts and support for small business and start-ups [19]. Recently, the Global Entrepreneurship and Development Institute (GEDI) ranked Australia third globally for overall entrepreneurship attitude and potential [20]. More specifically, the Global Entrepreneurship Index (GEI) 2015 report indicates that Australia excels in terms of opportunities for start-ups and its tech sector. In order to continue to foster a successful entrepreneurial environment, entrepreneurship needs to be supported as a valid and respected career choice, removing the associated stigma of failure and assisting in the creation of networking opportunities. In addition, support is required to boost the contribution of women, young people and immigrants to the entrepreneurial environment and acknowledge their innovation and talent.

Low cost digital entrepreneurialism implies lean innovation and the fail fast concept. Lean start-ups are embracing low cost entrepreneurialism – utilising digital platforms for low cost routes to market, allowing increasing numbers of small businesses to experiment with a variety of business models [150]. In the last five years, 'Lean Start-up' methodologies have enabled entrepreneurs to efficiently build a start-up by searching for product/market fit [151]. The primary activity of a start-up is to turn ideas into products, measure how customers respond, and then learn whether to pivot or persevere. Lean Innovation is an extension of the Lean Start-up principle – applicable to both new and established companies of any size – that exploits and explores this Build/Measure/Learn concept, not letting perfection get in the way of progress [152]. It applies the Pareto principle, that 20 per cent of a product's features will most likely deliver 80 per cent of benefits sought by customers [152]. Essentially, Lean Innovation is not a better innovation process but a more efficient learning process. The rapid scale up of new small businesses can be attributed in part to the Lean Innovation model, which favours experimentation over-elaborate planning, customer feedback over intuition, and intuitive design over traditional 'big design up front' development. It allows access to previously inaccessible markets, environments and opportunities – both locally and globally – without the often associated high risks.

Australian venture capital funding is declining. The Venture Capital (VC) sector is both exceptionally specialised and high risk. Funding new, innovative start-ups and rapidly growing companies is necessary in order to grow and diversify Australia's economy, particularly as the mining boom matures and traditional manufacturing diminishes. However, venture capital is not well established in Australia – accounting for only 0.02 per cent of Australian gross domestic product (GDP) [153], [154]. Additionally, Australia's venture capital sector has encountered a number of challenges, and funding for start-ups and early stage businesses has declined since the GFC [155] (Figure 17). Still, there are emerging industries that show promising growth in VC investment. The healthcare, life sciences, energy and environment sectors are likely to be key areas of focus among VC investors [155]. Taking into account the current entrepreneurial environment in Australia, development into a diverse and progressive economy requires a promotion of investment in innovation and growth of new businesses, and commercialisation of innovative ideas. Otherwise we risk losing our most valuable assets, innovation and creativity, to overseas investors who are much less risk averse and significantly more visionary [156], [157].

Figure 17 Declining Australian venture capital funding

Data source: ABS, Venture capital and later stage private equity [153]

By contrast, US venture capital funding is increasing. American venture capital has significantly increased investment into early stage start-ups since the GFC [158]. Venture capital investment is appealing to new start-ups and small businesses with limited operational history, usually considered to be too small to generate capital in their market and unable to secure finance through banks or other financial institutes. In addition to encouraging innovation, creativity and growth in the small business environment, venture capital is also correlated with job creation [159]. According to the National Venture Capital Association, each year almost two million businesses are established in the USA [160]. It is estimated that 600-800 of these acquire venture capital funding, with venture backed businesses accounting for 11 per cent of private sector jobs and venture-backed revenue accounting for 21 per cent of US gross domestic product. With US venture capital backed companies including Apple, Amazon, Starbucks and Google, the importance of such investment to the US economy is evident [161], [162]. Combined, the venture capital investment factors discussed above demonstrate the revolution taking place in the US economy today [163].

4.4 Divergent demographics

As with many other advanced and emerging economies, Australia's population is ageing with growing life expectancies. Retirement ages are likely to push back further and an organisation's employee profile is likely to contain more diverse age groups and cultural backgrounds. The rising incidence of diet and lifestyle-related chronic illness and improved understanding of mental health are likely to see these issues feature more prominently in the human resource strategies of large organisations.

The population in Australia is ageing and life expectancy is increasing. The Australian population over 65 years old is projected to nearly double by 2035, reaching 19.4 per cent of the total population compared to 15.1 per cent today [21] (Figure 18). Life expectancy at birth has been increasing for decades and is projected to reach 84.9 years for men and 87.9 years for women in 2035 compared to 80.7 years for men and 84.8 years for women today [21] (Figure 19). This trend implies the population's increasing dependency on those in the labour force. Dependency ratios, which measure the proportion of the population likely to be too old or young to work, have been falling since the 1970s. However, they have recently reversed and are projected to reach 60 per cent by 2046 [22]. The working age population is increasingly shifting into the older age brackets, and this is expected to continue [21], [164].

Figure 18 Share of working age population 2012 to 2035

Data source: ABS, Population Projections [165]

Figure 19 Life expectancy at birth: trends and projections

Data source: Treasury, 2015 Intergenerational Report [21] ABS, Australian Historical Population Statistics [166]

Increased labour force participation by older people might require a more flexible environment, for example shorter hours [21]. The numbers of aged care services and staff will also need to expand considerably to meet the growing demand from an ageing population and the decline in family support [167]. The aged care system is likely to need new models of care and adopt new technological solutions in order to meet the expected quality and quantity [167].

Participation in the labour force is expected to fall. Australia's workforce participation rate has been declining for almost a decade. The reasons behind it might include jobseekers becoming discouraged, casualisation of work, and the increasing potential for technological unemployment. The ageing trend is expected to result in a further decrease of overall participation in the labour force, despite the fact that older people are already working longer than previously [21]. Over the last 15 years, population ageing has subtracted 0.1-0.2 percentage points per year from the participation rate [164]. Workforce participation for people aged 15 and over is expected to fall from 64.6 per cent today to 64 per cent in 2034-35 [21]. On the other hand, workforce participation rate among older people is projected to increase from 12.9 per cent to 16.9 per cent by 2034-35 [21] offsetting the overall declining trend (Figure 20).

Surveys of generation Z (born in 1995-2009), which is about to enter the labour force, demonstrate that more than a half of surveyed teens expect to work to age 70 [47]. That will require the elderly to be more actively involved in economic activities, expected to result from longer life expectancy, new technology penetration and less physically involving work [21]. Working into older age might be more feasible for knowledge workers than manual workers and is likely to require complementarity with technology. Employers will need to manage an increasingly diverse labour force of different age groups, health and social status.

Figure 20 Workforce projected participation rate by age group

Source: Treasury, 2015 Intergenerational Report [21]

Female participation is rising, male participation is declining. Female participation in the labour force has increased steadily over several decades [22] (although flattened since the GFC), offsetting a smaller decline in male participation and contributing to increasing overall labour force participation (Figure 21). The same trend is observed in the numbers of higher education students (Figure 22). The number of working age men not in the labour force has more than doubled since 1978 [23]. Such men are typically single and have below average levels of education [168]. As low-skilled jobs are expected to be increasingly offshored or computerised [33], sections of the workforce may be displaced. If equivalent jobs are not available, these workers are likely to drop out of the labour force, which could further affect male participation rates. As women make up an increasing proportion of the labour market, more people will have to balance work and family responsibilities, so there will be an increasing demand for flexible working arrangements. Women are also still facing limited career progression, a gender pay gap (17.9 per cent at September 2015) [169] and lower retirement savings by almost half on average [170]. As female participation becomes crucial for economic growth the increasing economic independence of women, health and wellbeing issues are likely to be on the agenda for public and private employees.

Figure 21 Workforce participation rates

Source: ABS, Labour force Australia [23]

Figure 22 Higher education students by gender

Data source: Department of Education and Training [171], [172]

Australians are retiring later. The official retirement age in Australia has been increasing since the late 1990s, and is now 65 for both men and women. The effective retirement age in Australia, as in the majority of OECD countries, is below the official retirement age, although close for men [173] (Figure 23). The age at which people are eligible for the aged pension will increase to 70 years by 2035, which appears to be in line with effective retirement age growth and will contribute positively to labour force participation [21]. However, the gap between the pension age and effective retirement age for women is expected to persist.

Figure 23 Average effective retirement age in Australia

Source: OECD, Ageing and Employment Policies [173]

The ageing population, combined with longer life expectancy, may contribute to a retirement savings gap or shortfall in savings for a 'comfortable' retirement. An estimate of Australia's retirement savings gap was $727 billion ($67,000 per person) in 2013 [174]. People may have to work longer to save more for a longer retirement.

With the increase in retirement age and other proposed policy changes, government spending on age and service pensions will drop to 2.5 per cent of GDP by 2034-35 compared with 2.9 per cent today [21]. However, if no changes are implemented, spending will grow to 3.6 per cent [21]. Growing demand for aged care services is also projected to increase public expenditure from 0.9 per cent of GDP in 2014-15 to 1.3 per cent in 2034-35 [21]. Overall, the ageing population is expected to create an additional financial burden for the public budget as well as private savings.

Growth in skilled migrant workers. Net overseas migration has recently averaged 220,000 per year [21] (Figure 24). In 2013 it accounted for 60 per cent of population growth, while natural population growth (births minus deaths) contributed 40 per cent [28]. Arriving migrants tend to be in their prime working age and are highly likely to participate in the labour force. Over the last decade, around 83 per cent of annually arriving migrants were 15 to 64 years old with the majority (81 per cent on average) under 40 years old, while only 54 per cent of resident Australians were within the working age (15-64) [29]. A high level of migration might have a positive effect on the productivity of the Australian labour force, as migrants tend to have highly demanded skills, be better educated and motivated [21]. Over the last decade an increasing proportion of immigrants have come from non-European countries, particularly Asia. This shift of the country of origin for Australian immigration is projected to continue contributing to cultural diversity today, as well as impacting the future elderly population [22]. The latter would imply a demand for culturally, linguistically diversified aged care services [167]

Figure 24 Family and skill streams of migration

Note: A 'family stream' migrant is a person arriving to join other family members. A 'skill stream' migrant is a person arriving to work and fill a gap in the labour market.

Data source: Department of Immigration and Border Protection, Historical Migration Statistics [175]

Australian workers perceive themselves as 'healthy', however chronic diseases and obesity are on the rise. The proportion of working age Australians reporting their health as good reached 88 per cent in 2011-12 [176]. However, chronic diseases are the biggest challenge for population health and the leading cause of death [28]. A third of the surveyed population in 2007-08 had at least one chronic condition [28]. Research also demonstrates that socio-economically disadvantaged population groups in Australia face even higher risks of development of chronic conditions [177], raising issues of health inequality as a function of income inequality [178]. Chronic diseases have major impacts on health and productivity and are projected to increase, driven by changing lifestyles, dietary risks, smoking and ageing [28].

Nearly two thirds (63 per cent) of Australian adults were overweight or obese in 2011–12 compared with 56 per cent in 1995 [176]. Similarly, the majority of surveyed employees in 2014 were overweight (40.3 per cent) or obese (20.2 per cent) [24]. The prevalence of overweight and obesity is projected to exceed 70 per cent by 2025 [25]. Prevalence of diabetes in the population has also increased from 1.5 per cent to 4.2 per cent over 1990-2012 (although it has remained unchanged since 2008) [28], [179]. Over the last decade the prevalence of smoking among employees decreased from 20.5 per cent to 10 per cent which is lower than amongst the general population [24]. The prevalence of alcohol consumption at lifetime risk level also decreased [24].

The human resource strategies of future employers might need to address the increasing prevalence of diet and lifestyle related disorders. More specialists in exercise, diet and mental well-being will be required. New medical technology as well as robotification in medical diagnostics and care are likely to complement labour in the health care sector to meet the increasing demand [180]. In the US, a sharp rise in mortality and morbidity has recently been documented among middle-aged white people (though not in other demographic groups)[181]. While the causes are unclear it does indicate improved health and longevity cannot be taken for granted. Longer working hours may also be a problem. A recent study published in the medical journal *The Lancet* finds working more than 55 hours per week increased the risk of stroke by 1.3 times [182].

Mental health issues are prevalent in the Australian workforce. Nearly half of all Australians aged 16-85 report having experienced a mental health problem in their life [27], [28]. Between 1997 and 2007, the presence of mental disorder increased within most age groups, with a higher prevalence in youth and women (Figure 25) [26], [27]. Nearly a fifth of surveyed young people express serious concerns about depression [71].

Nearly two-thirds of Australian employees (65.1 per cent) reported moderate to high stress levels in 2013, a level which has been consistently growing from 2004 [24]. Workplace issues are reported to be the major cause of stress for two in five Australians [183]. A difficult work environment can also contribute to the emergence of mental disorders [184].

Unemployed, hence economically and socially inactive and disadvantaged people are more likely to experience mental disorders [27], [184]–[186]. Over a third (34 per cent) of unemployed women and nearly a third of unemployed men (26 per cent) surveyed in 2007 experienced a 12-month mental health issue as compared to only 20 per cent among employed people [27].

Although it is not certain whether the prevalence of mental health issues is increasing or whether there has been an increase in awareness, the total increased prevalence, especially among women and youth, is a concern which might have profound negative implications for the productive capacity of the future workforce.

Figure 25 Prevalence of mental disorders by age and sex in 1997 and 2007[1]

Source: Australian Bureau of Statistics [26], [27]

Awareness of mental health issues is increasing. There has been a rapid increase in the number of individuals accessing mental health services. Over the last decades Australian governments have been implementing the National Mental Health Strategy, including development of mental health programs and services, both community-based and institutional [28]. Because mental disorders vary considerably in severity, the demand for mental health services is expected to increase and diversify[28]. This implies a need to provide the population with a wider range of health services and new models of care including preventive therapy. Some of the support services, such as online therapy services for treatment of depression and anxiety disorders are likely to be facilitated by technology [28]. Others might need to be addressed by employers at workplaces.

4.5 The rising bar

The growing use of automated systems is increasing the complexity of tasks and requiring higher skill levels for entry-level positions. Income growth in Asia is associated with increased educational and skills levels, as well as growing competition for Australia's labour force. Many low skilled jobs are being offshored or automated. The consequence is likely to be a raised skills and education bar for entry into many professions and occupations. However, the quality of education and training is also improving. The higher bar may still be cleared by tomorrow's more skilled-up and better job seekers.

Education and skills are increasing in importance. The OECD economies, including Australia, are increasingly based on knowledge and information. The shift from manufacturing and agriculture to a service economy in Australia implies growth in demand for knowledgeable and skilled workers. In Australia, higher skilled occupations have seen rapid employment growth over the last two decades, and projections to 2019 indicate that this trend is likely to continue (Figure 26) [31]. In the knowledge economy, employability is directly related to education [30].

1 The demonstrated trends are indicative as the 1997 and 2007 survey methodologies differ.

Higher skilled jobs are more complementary with technology, increasing productivity and earnings [187]. These trends and projections highlight the importance of education for those who are yet to enter the labour market as well as emphasize a need for continuing education for those looking for career advancement [31].

Figure 26 Employment growth by skill level with projections until 2019

Note: Skill level refers to the qualification degree: level 1 – bachelor degree or higher; 2 – advanced diploma or diploma; 3 – certificate IV or III (with on-job training); 4 – certificate II or III; 5 – certificate I or secondary education.

Data source: Department of Employment [31], ABS, Labour Force [32]

Higher education enrolments are increasing. Domestic enrolment figures demonstrate that the fields of interest of current students generally match projections for future employment opportunities [188]. Increased enrolment in society and culture studies, education, architecture and building, coupled with the boom in health courses, would give upcoming graduates good chances to start their career immediately and contribute to the top growing industries - health and social care, education and construction. Health higher education completions increased by almost 100 per cent between 2001 and 2013. Degree completions in education, another key component of a knowledge economy, rose completions 25 per cent over the same period. However, a drop in IT enrolment (Figure 27) and lack of growth in interest in engineering raise concerns: skilled migration will likely be required to keep pace with business demand for these skills.

Increasing global competition in the labour market is also shrinking employment prospects for Australian graduates, as will be discussed below (see the trend 'The Australian workforce is susceptible to increasing competition from a rapidly educating Asian workforce').

Figure 27 Information technology studies completion trend

Source: Department of Education and Training [35].

A technology and knowledge driven economy needs workers trained in science, technology, engineering and mathematics (STEM). The majority (70 per cent) of employers in Australia characterise employees with STEM skills as the most innovative, and 75 per cent of the fastest growing occupations require STEM knowledge and skills [33]. STEM skills are likely to be required for work in a growing range of existing occupations in the future, and will also contribute to the creation of new professions [180]. However, current trends demonstrate falling interest in STEM among Australian youth. Between 1992-2012 participation by year 12 students in STEM subjects dropped by: 11 per cent for mathematics, 10 per cent for biology, 5 per cent for chemistry, and 7 per cent for physics [33], [34]. International PISA test results demonstrate that the performance of Australians in mathematics and science has also been declining since 2000 (Figure 28) [189], [190]. At the university level Australians also mainly target non-STEM fields of study (Figure 29) [86].

Figure 28 Performance of Australian students (mean PISA score) in mathematics and science

Source: OECD [189], [190]

Figure 29 Australian higher degree enrolments by field of study

Source: ABS, Education and Work [86]

Furthermore, STEM subjects and related occupations are traditionally seen as more male types of work. Enrolment in tertiary educational programs demonstrate that over the last 15 years the number of students enrolled in IT studies dropped more significantly for females than males (14 per cent vs 43 per cent in 2014 as compared to 2001), natural and physical sciences grew at a lower rate for females (63 per cent vs 76 per cent), although more females entered architecture and building programs and nearly the same growth rate was observed for engineering and related technologies [172].

Falling interest in STEM can be partly attributed to the increasing number of subjects offered to students, and may contribute to a more diversified workforce. However, given the growing importance of STEM knowledge for jobs of the future and the competitiveness of Australians in the international labour market, this falling trend in STEM knowledge and interest is a concern [34]. This situation needs to be resolved to meet future workforce needs, and provide employees, both males and females, with essential skills, promote innovation and productivity, and support economic growth.

Soft skills gap to be bridged. Australian employers also demonstrate increasing interest in the 'soft skills' of potential employees, namely personal, interpersonal and organisational skills [191]. Such skills are critical for the future workforce in terms of career and life success [192]. They include willingness to learn, interpersonal and communication skills, attitude and work ethic, self-management, teamwork and motivation, [191], [193] as well as critical thinking and imagination [33]. The university degree alone might not be a hallmark any more: innovative thinking and self-development as professionals are what can set a young employee apart [47]. Problem-solving skills and capabilities, including creativity and persuasion, will also be required to fulfil abstract, non-routine tasks which are less likely to be computerised [187]. At the same time, surveys of the upcoming generation of employees (Generation Z) indicate that they are likely to be comfortable working with technology but may be missing the core soft skills [47]. Soft skills development is therefore likely to become a key part of the agenda of educational providers as well as employers over the coming decades.

The cost of higher education is growing. The Australian Government is providing financial support to higher education primarily by means of teaching and research grants, student loans and student income support payments. In 2013-14 public expenditure on higher education exceeded $14.1 billion [194], and is expected to grow 5.8 per cent annually for the next 10 years [195]. Education is also costly to students. Both the number of students with a HELP debt (a government-provided loan for education), and the average HELP debt, have grown substantially. Today over 1.8 million people have HELP debts, owing a total of over $30 billion [195].

Rising education costs are likely to create an increasing burden on public expenditure, but also have the potential to exacerbate inequality if an increasingly expensive education is required to access a good job.

Online education is likely to complement university education. Massive open online courses (MOOCs) are gaining popularity among Australians, and the Australian universities which join MOOC providers including edX, Coursera and FutureLearn [194]. Enrolment in MOOCs is skyrocketing. For example, at the University of Queensland enrolments reached half a million students from over 190 countries, only 1.5 years after the release of its first open course [196]. Online education can provide more individuals access to tertiary level education at low or no cost, and without putting careers on hold. MOOCs have the potential to offer tertiary degree learning to people from disadvantaged socio-economic backgrounds (assuming access to broadband) and therefore contribute to equality in higher education. However, MOOCs do not provide degree qualifications yet, and course completion rates are low [197]. Surveys demonstrate that a typical current MOOC student is a young employed man with an already high level of education [198], [199]. The free learning opportunities provided by MOOCs are therefore used to satisfy curiosity, provide ongoing education and gain new skills for jobs without having to sacrifice careers and without the formal obligation of university studies [194], [198]. Therefore, online education is expected to contribute to the higher education service industry rather than replace the universities [194].

Teaching: less instruction, more mentoring in the life-long learning process. Information can be delivered online with teachers complementing online learning by facilitating, mentoring development of skills and discussing ideas in workshops [180]. Surveys already indicate that graduates would prefer to be better prepared for life while doing their degrees, with more placements and internships, and to be mentored by teachers with industry experience and knowledge [194]. They emphasise a need to enhance the application of learning [191]. At the same time, the new generation of workers are expected to seek ongoing, life-long learning. Surveys of Generation Z indicate that they see mentoring and training from leaders as an important part of their future work environment [47]. Gen Z as well as Gen X (born 1965-1979) are prepared for, and will be seeking, continuous learning in the workplace [200]. This will raise challenges for higher education providers as well as for employers in managing of staff, an increasing proportion of whom are likely to be knowledge workers.

Rising inequality is likely to limit income prospects for the future labour force. Over the last few decades income has become more unequal in Australia and most OECD countries. The socio-economic systems of the countries with higher income inequality limit the opportunities for the development of skills and abilities in children, as well as their future job prospects [201]. The gap in earnings between people with and without higher education is increasing: in the OECD, between 2008-2010 this gap increased by 9 per cent on average [30]. Skill level becomes a factor of job polarisation. Australia is among the countries with a medium inequality level [201]. It also has an OECD-average proportion of 'resilient' students or students who perform better than would be expected given their socio-economic status [201]. However, increasing inequality in Australia raises concerns for the future [202]. A continuing decline in the labour share of the national income in Australia, as in other developed countries, [203] might also be contributing to the increase in income inequality [204], [205]. Although people from disadvantaged backgrounds are less likely to attain tertiary education qualifications [191], those who do participate in university study and complete a degree have similar employment opportunities to other graduates [191]. The university system therefore can help to ameliorate socioeconomic differences [191] and income inequality. Equitable distribution of educational opportunities is associated with equitable distribution of income around the World [201].

The Australian workforce is susceptible to increasing competition from a rapidly educating Asian workforce. The number of young people with tertiary-level education is rapidly growing globally. In 2012 every third adult in the OECD had attained a tertiary degree [36]. Over the last decade a gap between the number of people with tertiary education from OECD and non-OECD countries has closed, and by 2030 70 per cent of people with tertiary education are expected to be from non-OECD countries [37]. By 2030, China and India are expected to provide nearly half of all people with tertiary education aged 25-34 in the world and over 60 per cent of the STEM qualified workforce for the G20 nations [37].

Graduate survey data reveals that graduate employment prospects in Australia have been getting worse [194]. In 2014, only 68 per cent of bachelor graduates could find full-time employment shortly after graduation (Figure 30), the lowest number in over three decades.

Figure 30 Proportion of bachelor degree graduates working full-time of those available for full-time employment

Source: Graduate Careers Australia [206]

However, university education still offers better employment prospects, and therefore insurance against low income [191], [194] for future workers. A growth in the number of people with a tertiary education can become a national goal as a means of protection of the future labour force.

4.6 Tangible intangibles

Employment growth in the service industries, in particular education and healthcare, has driven job creation in recent times. This is likely to continue into the future as we move into a knowledge economy. Service sector jobs requiring social interaction skills and emotional intelligence will become increasingly important. Also within this megatrend are the new expectations of younger generations entering the workforce, who are connected, technologically advanced, creative and entrepreneurial, and have new perspectives on desirable work environments, ethical issues and communication styles.

Australia is in transition to the knowledge economy. As a subset of the service economy the knowledge economy is based on knowledge and information [207], which forms the intellectual capital of organisations [200], and is a driver for growth and employment across industries [208]. Knowledge-rich industries, including professional, scientific and technical services, show rapid growth of value added in Australia (Figure 31). This trend is expected to continue in the future.

Figure 31 Gross value added by industry (indexed, 1975 – 100%)

Source: Australian Bureau of Statistics, Australian National Accounts [209]

Patent growth is one of the indicators for innovation and growth in the knowledge economy [39], [207], [210]. The number of patent applications in Australia increased by nearly 50 per cent between 1999-2013 [38], [39]. The growth rate for IP filings exceeds the GDP growth rate (Figure 32). Although this indicates a transition to the knowledge economy, it is modest by international standards. For example, in China the number of patent applications over the same period (1999-2013) increased more than 16 fold. The number of patents leading to commercialised disruptive products is not clear, thus the location of disruption is also unknown.

Figure 32 IP Filings and GDP growth in Australia (indexed 1999 – 100%)

Source: World Intellectual Property Organization [38]

Health care and professional services are leading employment growth. Over the past five years the occupational groups which contributed most to employment growth in Australia were health care, social assistance and professional scientific and technical services – offsetting falls in manufacturing, agriculture, forestry, fishing and mining [31]. This trend is expected to continue (Figure 33). Driven by population growth and an ageing population, the highest growth in employment is projected to be in health care and social assistance (by 18.7 per cent to November 2019), and education and training (15.6 per cent). Construction (13 per cent) and professional, scientific and technical services (14.4 per cent) are also anticipated to expand [31]. These projections, together with an expected employment decline in manufacturing and mining, reflect the transition to a knowledge economy.

The experience economy continues to expand and diversify. The experience economy is the next step in the chain from an agrarian, industrial and service economy [211] and a progression of the value added by the creative economy [212]. In the experience economy, businesses create memorable events for clients, where the memory itself and enriched experience become the product [211]. Experiences challenge senses. They can be physically active (e.g. adventure tourism) or passive (e.g. movie watching), involve technology, stimulate learning [213].

Figure 33 Employment growth projections by sectors (2014 to 2019)

Note: * - including administrative and support services, public administration and safety

Source: Australian Government Department of Employment [31]

Bricks and mortar retail in Australia are one of the first to move towards this model, to compete with the growth of online stores. Personal trainers, life coaches, tourism and entertainment advisors and similar service professionals, are set to play a significant role in an experience economy. However, fitness professional data shows an abundance of predicted future supply, indicating the field will become more competitive. There are early signs of an experience economy emerging in Australia, but it is likely to be a successor to the services economy.

Employment in the creative sector is growing. The digital revolution and an increasing demand for design services are driving the growth of the creative sector [41], which extends from arts to science and technology, and involves cultural creativity and innovation [214]. The value added by the creative sector, measured as copyright industries contribution to GDP in Australia, has been increased in real terms from $89.5 billion in 2002 to $111.1 in 2008. It has since stabilised, contributing between 7.1 per cent and 8.2 per cent of GDP annually [42]. That proportion is above the average of 5.2 per cent across 40 countries [214]. The new generation of workers (Gen Z) appears to be creative and looking for opportunities to express it. Nearly half (42 per cent) of Gen Z-ers express an interest in working on a craft [43], 76 per cent wish their hobby would turn into a full-time job [44] and the majority (89 per cent) indicate they are looking for productive and creative activities for their free time [43].

In these regards, the creative sector is expected to become increasingly important as a contributor to the national economy and the job market. Existing and new jobs are likely to require a creative approach to perform non-routine tasks and solve problems, while future workers are likely to appreciate an opportunity to act creatively.

Generation Z will enter the workforce with new expectations. Generation Z is generally used to refer to people born during 1995-2009. They are also referred to as 'digital natives' as they have grown up in a world of digital technology and internet connectivity, unlike older generations, who remember working and living in a world without the internet. Several features characterise Gen Z-ers as the workforce of the future:

- Digital: Gen Z-ers are constantly connected to online computing devices, with nearly half of surveyed teens connected for over 10 hours a day [45].
- Entrepreneurial: surveys demonstrate that from 17 per cent [46] – 20 per cent [47] to 62 per cent [43] and 72 per cent [215] of them want to start a business as compared with 11 per cent of Gen Y [46]; 32 per cent believe that within 5 years they will manage other employees [47].
- Pragmatic: Gen Z-ers expect they will have to work harder than previous generations [47], [216]. They are ready to go through failures before achieving success [43].
- Looking to change the world: among the top motivating factors, Gen Z-ers name advancement opportunities (34 per cent); money (27 per cent) and meaningful work (23 per cent) [46]. Most respondents (60 per cent) want their job to have impact on the world [44] and society [47].
- Collaborative: over 50 per cent of surveyed youth indicate their preference for face-to-face communication rather than via technology [46]. Gen Z-ers indicate a preference to work in collaboration with a small team and work from the office (Figure 34) [47].
- Continuing learners: the Gen Z-ers are expected to appreciate a working environment which can provide them with continuing learning and mentoring opportunities [44], [47] and feedback [47].

Figure 34 Work environment preferences of Generation Z

Source: Robert Half and Enactus [47]

Generation Z might therefore bring a new set of intangible experiences they expect from their work environment. That might imply a need to develop new solutions for the working environment and recruiting, such as bring your own device policy (BYOD), creativity and learning-stimulating working arrangements.

5 THE SCENARIOS

The scenario planning model requires the identification of axes which represent continuums of possibilities at a future date (2035 in this study). The axes capture critical uncertainty and impact in the megatrends narrative. In reality there are countless sources of uncertainty and impact buried within the trends and megatrends. However, the scenarios cannot capture everything that matters in detail. Rather, they create a simplified model of a much more complex reality. To do this we select axes which have the highest level of impact and uncertainty. We have identified the extent of task automation and the extent of institutional transformation for the two axes (Figure 35).

Both ends of the technological change axis describe a future with more automation in the workplace than exists today. However, there is much uncertainty about the reach of automation — from slightly more to vastly more. There is a future where the promises of artificial intelligence come to fruition and the vast majority of human tasks are performed better, faster, more safely and more cheaply by robots. This highly automated workplace creates job opportunities, and requires skills, very different from those that exist today. There is also a future where artificial intelligence has failed to deliver on its promises and in which some job tasks have been automated, but many have not. In this future the jobs and skills required are not too much different from now. Which one of these two futures eventuates will have an impact on Australia's labour markets.

Figure 35 Scenarios for jobs and employment in Australia in the year 2035

Likewise the extent of institutional transformation is still subject to considerable uncertainty. There is a future in which the peer-to-peer marketplace and platform economics enabled by digital technologies radically transform the structure of organisations and employment models. In this future the majority of Australian workers might be freelancers or portfolio workers with many employers across the globe. They may also work from numerous geographic spaces within co-working spaces designed to meet their needs. However, there is also a future where these models fail to take hold and traditional employer-employee structures hold constant. The peer-to-peer marketplace has yet to clear hurdles such as broad-based consumer trust, government regulation and competition from longstanding incumbents.

Other aspects of the megatrends narrative are important but do not have the same level of both impact and uncertainty. For example, demographic change and the rise of the service sector industries (described under divergent demographics) have considerable impact but limited uncertainty. Australia's aged population forecast is proving reliable: the actual and predicted lines for the percentage of population in aged cohorts are following a near identical pathway. Likewise the growth of income, education and skills levels within the emerging economies of Asia captured under the rising bar is highly likely to continue apace.

The two axes combine to create four quadrants and four scenarios. The titles of the scenarios draw upon the metaphor of four water bodies - lakes, harbours, rivers and oceans. The depth of water describes the amount of task automation. Deeper water bodies — harbours and oceans — have more task automation than the comparatively shallower lakes and rivers. The speed and strength of water flow (and tides) describes the extent of institutional change. The stronger tides and water currents of rivers and oceans imply greater institutional change compared with the stiller waters within lakes and harbours, which imply less institutional change and more stable market structures. In the remainder of this section we describe the two axes and the scenarios they create. We aim to give reasons that the future might lie at either end of the axis. Because of uncertainty multiple futures are possible.

5.1 Horizontal axis – extent of institutional change

The horizontal axis relates to the extent to which institutions, covering everything from social norms through to business structures and laws, change over the next 20 years. A future in which nothing changes was not viewed as plausible. Recent legislation targeting the P2P economy include Uber supportive regulation in the ACT, and a review of Airbnb zoning regulations in NSW, demonstrate a willingness to embrace change [217]. However, it is uncertain how fast, and how far, institutions will change. It is important to note that it is the consensus of people and society that drives change: technology is only a facilitator. There is structural change at both axis endpoints, however the extent of change varies considerably.

5.1.1 LIMITED INSTITUTIONAL CHANGE

Although digital technology is lowering transaction costs in some areas, it has yet to destabilise the existence of firms. On the left side of the axis, firm structure is largely unchanged. At this axis endpoint firms are structured much as today, with only modest disruption from digital platforms. Issues associated with trust and enduring long-term relationships mean that, despite rapid recent growth, P2P employment models fail to take hold and soon plateau. While simple, short term services like car rides or overnight accommodation are successful in the P2P economy, issues with employee reliability and employer non-payment prevent higher skill jobs going freelance.

This pushback to the P2P economy can already be seen today. Taxi companies around the country are rallying against Uber, insisting on comparable standards of regulation [218], [219]. The government is also curtailing P2P growth by enforcing taxation on the emerging sector [220]. On the left end of the axis, employees reject portfolio and freelance work models in favour of security of tenure. Likewise employers value enduring employee relationships which facilitate the creation and retention of skills and experience.

A high labour cost services economy such as Australia could struggle to compete in a truly global peer-to-peer environment. In such a world, Australians wishing to become freelancers must compete against lower wage expectations from less wealthy countries. Upwork's *Annual Impact Report* from 2014 lists the top five freelancer countries as India, United States, Philippines, Ukraine and Pakistan, a list dominated by low labour cost countries [221].

Institutional inertia means that hierarchical structures can be slow to change regardless of enabling technologies or cultural and economic trends. At this axis endpoint, employees remain comfortable operating within clearly defined hierarchies. Both private sector companies and governments remain confident that hierarchical structures, while less agile, remain most efficient for managing large workforces.

On the left side of the institutional change axis, society has chosen to remain more conservative. Issues arising from increases in task automation are not directly addressed; their consequences are dealt with in an ad hoc fashion. As technology advances, legislation fails to keep pace, stalling the implementation of cutting edge technologies, such as driverless vehicles.

5.1.2 SIGNIFICANT INSTITUTIONAL CHANGE

Digital platforms enable short-term and task-specific job contracts to be negotiated and delivered with minimal transaction costs. This makes some roles in traditional firms redundant, giving rise to more agile, networked and flexible employment models. Digital technology and social media are changing internal and external information flows for organisations, both government and private. At the axis end point, hierarchical relationships can be replaced by functional relationships as decision making autonomy becomes distributed across organisations.

Firms (and government departments) have become smaller, relying on networks of other small firms and independent workers to work on projects as required. Just as manufacturing become more efficient in the 20th century by reducing inventories with just-in-time supply chain management, so human resource managers in the 21st century seek to minimise their employee inventories.

Freelancing and peer-to-peer employment platforms such as Freelancer and Upwork, plus crowdsourced problem solving platforms such as Kaggle and Innocentive are experiencing rapid growth. This trend can already be seen, with Australia ranked second in terms of spending on freelancers in 2014, according to Upwork data [221]. At this end of the axis, these models successfully facilitate trust and reliability (for both employers and employees) and continue to grow and diversify, eventually becoming a sizeable component of the labour market. Society latches onto a highly flexible working life, with individuals fitting paid work in and around their other activities.

Education and training is becoming more globalised. The rise of online education has allowed students to receive lectures from world leading educators, supported by local tutors and learning facilitators. Education providers are able to remotely deliver their courses in increasingly engaging ways, opening up new markets of students. This trend is already well underway, with the global market for e-learning in 2015 worth $US107 billion [222].

On the right side of the institutional change axis, society has chosen to become more accepting of reform. New legislation enables flexible employment models. A shift towards horizontal management structures empowers workers with more autonomy in decision making. Society is able to choose appropriate balances between work and recreation. As task automation impacts jobs, government and society respond proactively, offering a stable safety net to affected workers during periods of industry transition.

5.2 Vertical axis – extent of task automation

The vertical axis relates to the extent of task automation in the future workplace. It is stressed that at both axis endpoints task automation does occur and certain jobs are disrupted: the employment landscape is not the same as today. Neither axis identifies a future with less technology driven task automation as this trend has existed throughout human history, accelerating since the industrial revolution.

5.2.1 LOW TASK AUTOMATION

A future with less technology than the present is highly unlikely, so the lower end of the axis still encompasses technological progress. However, many technologies do not prove good enough for widespread adoption; for example, while driverless cars work well in most situations, they are not sufficiently reliable to be widely used.

Interoperability already plagues digital tools. As more competing products are built the problem continues to worsen, limiting the impact on existing jobs. The constraints of legacy systems and the cost of large scale IT projects restrains the implementation of cutting edge automation methods. Existing automated systems are upgraded infrequently due to the labour, capital and short term productivity costs of such tasks.

Although robots play an increasing role in controlled factory-like environments, they remain unable to compete with humans in the unstructured environments outside. New tools, such as 3D printers and advanced computer aided drafting (CAD) systems increase the productivity of physical workers without displacing their jobs.

5.2.2 HIGH TASK AUTOMATION

At this axis endpoint there are exponential increases in the capabilities and adoption of a broad range of technologies including sensory systems, artificial intelligence, data analytics, e-commerce and other digital technologies. If current trends continue, technological capabilities beyond 2025 will be vastly superior than today. Already many jobs are being impacted as increasing numbers of tasks are done more effectively and efficiently with robotics and computerised automation.

While current estimates suggest 40-50 per cent of jobs are at risk of automation [7], [33], it is possible that technological progress could impact many more. For example, the development of empathetic artificial intelligence might substitute many human service delivery roles. However, the digital economy will also create many new jobs, and maybe even industries, which in some cases will be entirely new. This end of the axis is about a future where digital technology does more to the workforce than most currently anticipate.

Increases in task automation would be likely to have an amplifying effect on the institutional change axis. As new technologies come online and existing jobs are displaced, society will be under greater pressure to adapt.

BLAM!!!

5.3 Scenario 1 – Lakes

This scenario is similar to the present day situation in the level of task automation and the structure of organisations, society and the workforce. Current trends in automation will continue: for example, factories are likely to become more automated, and the peer-to-peer economy will grow, but changes will be measured and gradual.

Employment is more stable under this scenario, as digital disruptions are unlikely to suddenly displace large sections of the workforce. However, without rapid technological improvements or efficiency gains from structural reforms, productivity growth will be constrained.

A future in which Australia is comparatively slow at adopting new digital technologies and realising digitally enabled structural change would have consequences. If Australia fails to change while the rest of the world undergoes a technological revolution, there will be serious consequences for employment. The ease of outsourcing will increase with technological progress, allowing foreign task automation to replace jobs which do not require a specific geography. Likewise, foreign task automation will drive down the cost of imports, with impacts on local manufacturing, construction and agricultural jobs.

The porous boundaries megatrend is already having a significant influence on service jobs not requiring physical components. Freelancing has opened up an agile and flexible network of professionals. In the second week of November 2015, freelancer.com had over 3,100 graphic design jobs advertised, representing only a small sample of the total P2P marketplace [223]. Wages paid for graphic design on freelancer.com are far below Australia's domestic expectations; the global P2P economy is likely to disrupt similar professions across Australia.

5.3.1 A DAY IN THE LIFE OF 2035 (UNDER THE LAKES SCENARIO)

In 2015 Tom worked as a retail manager. At the time retail managers were Australia's third largest occupation, with 235,000 retail managers employed across Australia, making up 2.6 per cent of the workforce.

Over the next ten years, retail was in a state of flux. Global competition from low cost online stores cut heavily into the profit margins of traditional Australian retailers. In an effort to adapt, floor space was reduced and sales staff cut back across the nation. Traditional retailers built online stores in parallel to their existing operations.

Today, in 2030, retail has become less about large malls and mass access to goods, and more about the shopping experience itself. Online purchasing has become the norm, however convenient product sampling and demonstration ensure that bricks and mortar remain relevant.

Tom still works in the retail management. He has been promoted to regional manager, but the nature of his job has changed. Retail managers make up a much smaller proportion of the workforce and the job description now centres on delivering memorable experiences to shoppers. Tom's KPIs are now concerned with the long-term brand loyalty he can build with visitors to his stores, tracked through his company's customer loyalty program.

Tom is now expected to develop the customer interaction skills of his sales staff. He runs workshops briefing the staff on the feature sets of new products, and conducts role plays demonstrating positive ways to relay this information to customers. He ensures his staff understand 'brand guidelines' for customer interaction. Leveraging customer research coming out of head office, he ensures his staff are doing their upmost to convert new customers, and encourage existing customers to stay with the brand.

Quality retail employees now excel at the theatre of creating positive memories around a shopping experience. Although online stores represent the majority of sales globally, bricks and mortar, coupled with a quality shopping experience, are still a powerful tools for building brand loyalty.

5.3.2 KEY IMPACTS

GROUP	IMPACTS
Employees	• Employees face the least disruption to employment under this scenario. • Automation progresses slowly, mostly affecting mining, manufacturing, agriculture and logistics. • Non-geographically specific jobs (for example, graphic design) face increased international competition.
Employers	• Labour costs continue to increase, making Australian businesses less internationally competitive. • Digitising operations and innovating become less important as genuine disruptions to industries are few and far between. • Sourcing elite ICT talent and upgrading ICT infrastructure is not mandatory for success, freeing up capital for other business areas.
Education and Training Providers	• Education is less disrupted by e-learning under this scenario. Local teachers, tutors and accreditation remain the norm. • As more classes are offered online, some components of delivery become automated year to year. The change is minor. • Less disruption within industries means upskilling mature workers is not a top priority.
Society	• With the structure of employment remaining largely unchanged, income inequality remains at similar levels as today. • Australians continue to place high value on local jobs and products, allowing local industry a competitive niche against foreign players. • Equality of opportunity for employment is a high priority, society strives to keep unemployment down.

5.4 Scenario 2 – Harbours

In this scenario the promises of artificial intelligence, automated systems and technological progress have been fully realised. Technology is capable of automating a wide range of manual and knowledge oriented tasks, and has moved further and deeper into the automation of non-routine tasks via advanced artificial intelligence.

However, while technology has replaced many jobs there have been few changes to employment models. The large firm employing significant numbers of people in a hierarchical structure remains the dominant model. There is little movement in peer-to-peer employment from the current situation and the population of portfolio workers remains proportionally similar to today.

There is also a shift towards a more inclusive workforce, as companies improve human resource management strategies to synergise with innovative government employment policies. However, the side effects of changing employment models are too huge to be fully addressed. Many school and university graduates, as well as mid-career workers, are ill equipped to succeed in the new employment landscape. Many people struggle to transition careers. While some succeed and flourish, others struggle to adapt, resulting in an increasingly polarised labour force.

The divergent demographics megatrend has highlighted transitional impacts on older generations of workers displaced from their careers. Working age men with low educational qualifications are particularly affected; since 1970 the number of 25 to 55 year old men not in the workforce has doubled, from 5 per cent to 10 per cent [23].

On the employer side, the second half of the chess board megatrend is setting the direction of task automation. The 2015 CEDA report on Australia's future workforce highlighted the productivity gains being made by Rio Tinto as they move to automated vehicles and drills [40]. Automation is likely to spread to rapidly spread into other industries, initially replacing lower-skilled jobs.

5.4.1 A DAY IN THE LIFE OF 2035 (UNDER THE HARBOURS SCENARIO)

In 2015 Sally worked as a truck driver, moving goods across the state between her company's warehouses. At the time, truck drivers were Australia's sixth largest occupation, with 178,400 people, representing 1.6 per cent of the workforce.

Over the next ten years, the profession was subject to significant disruption. Large mining and agricultural projects were the first to move to fully automated vehicles as technology advanced. With a large number of drivers competing for a declining number of jobs, pay and conditions were pushed lower. Still, there were more drivers than jobs, and without other skill sets to fall back on many drivers dropped out of the labour force entirely. Of those that remained in work, many had to step out of their comfort zones into jobs unrelated to any of their prior experience. With most jobs growth coming from the services sector, this transition was quite difficult for some.

Today, in 2030, only urban routes remain open to truck drivers, with automation having taken long distance jobs. The technology exists for the job to disappear entirely, however society is not comfortable with driverless vehicles operating in built up areas. Drivers still in the job have had to be upskilled to work with new on-board systems.

Sally still works as a truck driver, but spends very little time manually controlling the vehicle. She starts her morning at an interchange on the outskirts of an urban area. Her day is planned down to the minute through automated scheduling. Trucks required to make deliveries into population dense zones first stop at the interchange to allow Sally to board. Sally monitors the vehicle's systems during the trip, scans the road for unpredictable hazards, and remains prepared to take the wheel in the event of a systems malfunction.

In addition to physically supervising the operation of the vehicle, Sally is expected to deal with customers. A proportion of her deliveries are to individuals, she is tasked with ensuring that delivery remains up to their high expectations, which reflects on her company's brand.

Sally is aware that her profession is in decline. With typical retirement not occurring until a person's late 60s, Sally has to prepare for a transition into another career. Support for this transition is limited; she has to do her own research, source her own education loans and hopefully navigate her way successfully into a new industry.

5.4.2 KEY IMPACTS

GROUP	IMPACTS
Employees	• Employees likely face the largest disruption under this scenario as automation impacts entire industries. • Older workers displaced from manufacturing struggle to transition to new careers in a services/experiences dominated economy. • Lower skill white collar jobs decline at similar rates to manufacturing and agriculture jobs as automation advances.
Employers	• Productivity increases significantly across industries able to leverage the full capabilities of task automation. • The returns to capital (particularly intellectual property) increase as task automation decouples growth from labour costs. • Incumbents face major disruption across a variety of industries as barriers to entry for competition break down.
Education and Training Providers	• Technology enables the efficient delivery of quality online courses to wider groups of people at lower cost. • Primary and secondary education providers leverage technology solutions to centralise curriculum and deliver a consistent baseline education. • Local universities struggle to compete against international online education providers with certified accreditation.
Society	• Global economic growth is strong. Wealth increases in Australia, but so does inequality. However, global inequality declines as more workers from initially poorer countries get access to the global labour market. • The social consequences of worker displacement are dealt with non-optimally, in an ad-hoc fashion. • Rising inequality leads to protest movements in many countries.

5.5 Scenario 3 – Rivers

In this scenario technology has advanced more slowly than many envisaged and task automation has impacted relatively few jobs. Cybercrime and privacy concerns have been key blockages to automation's push beyond factories, warehouses and mine sites. Although the technology increasingly exists, it remains cheaper to employ people than invest in complex automated systems and deal with their maintenance.

While the technologies have advanced only incrementally, the organisational structures, workplace cultures and the means via which employers recruit and engage staff have changed substantially. The population of portfolio workers and freelancers has risen sharply. Peer-to-peer models are mainstream forms of employment, although Australia struggles to complete in some components of the global peer-to-peer services market.

The geography of white collar work has become more flexible. An increasing portion of tertiary graduates enter the workforce as entrepreneurs, creating their own jobs. Office hubs and innovation centres allow company employees and entrepreneurs to co-locate themselves with clients and likeminded individuals outside of traditional CBDs. Inner city transport networks are better able to cope under this scenario and white collar jobs become more geographically distributed.

There is a shift towards a more inclusive workforce as private and public sector policies adapt to the new structures. As always, change impacts some more than others. Industry deregulation significantly disrupts incumbents, but the overall demand for employment remains strong. Business owners are also forced to remain adaptable as they grapple with new disruptive business models, increasing the risk associated with large capital investments. Wealth inequality remains similar to today's world. The net supply of job opportunities is constant for full time workers, with increased opportunities for casual or part time workers.

Under this scenario, the era of the entrepreneur megatrend comes to the fore as capital flows, currently constrained in Australia, are opened up to smaller businesses. This is similar to real world effects in present day America; since the bottom of the global financial crisis, American venture capital going into early stage projects has increased five hundred percent [158]. The resulting uptick in business activity can be seen as a significant part of America's economic recovery.

5.5.1 A DAY IN THE LIFE OF 2035 (UNDER THE RIVERS SCENARIO)

In 2015 Jack worked as a secondary school teacher for a local state school. At the time, secondary teachers were Australia's twelfth largest occupation, with 143,700 people representing 1.3 per cent of the workforce.

Over the next ten years, the profession underwent significant change. The emergence of e-learning, and a globalised education market allowed world class educators to reach classrooms across Australia. The role of the classroom teacher became one of facilitator, to encourage children to think critically about what they were learning, and guide them through the practical application of skills. Digital literacy was emphasised as technology found its way into more aspects of life, as well as interpersonal skills as the majority of jobs shifted into the services sector.

Today, in 2030, the number of secondary teachers remains relatively unchanged, having kept pace with population growth. However, the method of teaching and administrative structure of schools has changed. Teachers spend less time lecturing to the class, instead facilitating discussions arising from the interactive digital lectures delivered to students as part of the standardised curriculum. Teacher allocation and continued education is handled by centralised systems, allowing principals and administrative staff to focus on the wellbeing of children, the community, and upkeep of school facilities.

Jack is still a secondary school teacher, although he has decided to reprioritise his family over work. He now operates as a relief teacher for his area. Each morning, as teaching vacancies are identified, a list of classes is pushed to one of Jack's devices. He fills up his calendar as he sees fit, and the scheduling is handled via automated systems. A relief teacher is not always available, but the core curriculum can still be delivered to students via interactive digital lectures, so missing a day or two of facilitation is not overly detrimental.

Examination has been centralised along with lecture delivery, allowing quick analysis of student results. Continuous non-formative assessment gives regular feedback to Jack on the performance of classes he teaches. If Jack's students begin to have below average outcomes, the state organises non-punitive interventions to help improve Jack's teaching abilities. Although the role of secondary school teacher has evolved into more of a facilitator it remains respected in the community. Teaching wages are stable, and the job continues to have long term security of tenure.

5.5.2 KEY IMPACTS

GROUPT	IMPACTS
Employees	• Employees receive more favourable conditions as government policy incentivises low unemployment in innovative new ways. • Knowledge workers are offered more freedom around the geography of their work as office hubs spring up. • The peer-to-peer economy enters the mainstream, offering a more flexible work life to those with the risk tolerance to take it.
Employers	• Companies begin to decentralise decision making, adopting horizontal management structures to increase firm agility. • Venture capital and bank lending becomes more readily available to SMEs as risk is better understood, allowing growth in the sector. • Deregulation of industries impacts incumbents as small innovative firms become more aggressive and the P2P economy takes hold.
Education and Training Providers	• Steady deregulation of education puts Australian tertiary institutes in more direct competition with international institutes. • Universities are threatened by online courses, but the vocational sector is more protected due to its large practical components. • Primary and secondary schools shift their focus towards skills of the future. Knowledge and people skills are actively developed.
Society	• Society acts to narrow inequalities in income, healthcare and education. • A growing peer-to-peer economy fosters a sense of community and allows wider networks of people to tackle community issues. • More flexible employment allows shorter work weeks, with more time for family and community activities.

5.6 Scenario 4 – Oceans

In this scenario the promises of artificial intelligence, automated systems and technological progress generally have been fully realised. Technology is capable of automating a wide range of manual and knowledge oriented tasks. Technology has moved further and deeper into the automation of non-routine tasks via advanced artificial intelligence.

Organisational structures, workplace cultures and the means via which employers recruit and engage staff have all changed substantially. Modern ICT has allowed organisations to centralise decision making without relying on large hierarchical structures. Portfolio worker and freelancing has entered the mainstream as peer-to-peer business models become more commonplace. Many organisations are virtual networks of skilled staff that expand and contract rapidly, based on supply-demand cycles and surges.

The boundaries around companies, jurisdictions and professions are highly porous and have been broken down as employees and employers form connections wherever it makes sense. Task automation has centralised an increasing number of factory, warehouse and agricultural jobs, creating difficulties for rural towns. The workforce has also become highly inclusive. Labour markets are efficient with minimal transaction costs, as employers and employees come together reliably and quickly.

Highly effective life-long education and training programs, plus a widespread cultural and attitudinal shift, sees the vast majority of people able to transition careers. Although automation and technology destroy some jobs, many more new jobs are created across new and exciting sectors.

Task automation (second half of the chessboard megatrend) will impact opportunities for young people trying to get their first job. Historically task automation has worked from the bottom up, removing low skill, entry level jobs first. It will also force many less skilled older workers to find new industries. The green revolution in America saw agricultural employment drop from 70 per cent of the workforce in 1840 to less than 2 per cent today [224]. While automation destroyed many agricultural jobs, resulting productivity boosts led to a net increase in employment, predominately in a growing services sector. A smooth transition for affected workers through the current phase of task automation requires structural change and societal support.

5.6.1 A DAY IN THE LIFE OF 2035 (UNDER THE OCEANS SCENARIO)

In 2015 Jill worked as a labourer on a mining site. At the time there were 7,800 mining labourers employed across Australia, representing a small section of the workforce. Over the next ten years mining employment fell into a sharp decline. At the bottom of the resources cycle there were few new mine developments, resulting in limited creation of new jobs. In addition, automation was replacing the majority of non-engineering roles on site.

Government was able to proactively intervene with retraining opportunities. Tourism was undergoing significant growth, and short training courses were offered to transition labourers into the sector. TAFEs also stepped up, partnering with industry to deliver government supported trade qualifications to the influx of displaced workers.

Today, in 2030, the number of mining labourers is a fraction of what it once was. Although jobs exist during the development of new mines, these developments are few and far between. The majority of Australian mining sites are in the operational stage, with automated technologies carrying out most of the physical work. Many rural communities reliant on servicing mines have dwindled as the geography of employment changed.

Jill lost her job in the mines some time ago. After several months searching for new labouring jobs with little success, she decided it was time to investigate the retraining options. She decided to take the skills she developed tackling mine site erosion and build on them with a landscaping apprenticeship. Aside from the traditional physical and design skills required in landscaping, TAFE training was able to build Jill's digital literacy.

Physical tasks like landscaping thrived in Australia's peer-to-peer economy, as they didn't face direct competition from low wage nations. Digital networks allowed Jill to enter the market as a self-employed individual immediately after completing her apprenticeship. She was able to source apprentices and labours on a job-by-job basis with little difficulty, with online systems handling administrative issues such as taxation and payroll. Her training also helped her develop customer relation skills, which she sees as the most challenging part of her job. Jill is now an effective communicator, with quality online reviews of her professionalism and performance as a landscaper.

A variety of automated technologies assist Jill in her work. She carries a portable device able to take a 3D image of a landscape, then list the species of plants likely thrive in the climate, along with example configurations. Jill can readily edit these configurations and the topology of the land, rapidly iterating designs until the client settles on their favourite. Robotic arms greatly reduce the labour required in repetitive tasks such as tile laying, and 3D printers open up a slew of low cost opportunities to bring distinctive touches to each project.

5.6.2 KEY IMPACTS

SECTOR	IMPACTS
Employees	• Employment disruption occurs across multiple industries, however government intervention supports career transition pathways. • Although job destruction occurs in lower skill tiers, the net number of jobs expands, with new jobs and industries paying better wages. • The experience economy takes over from its services/knowledge predecessors. People skills become increasingly important.
Employers	• The most dangerous jobs across workplaces are automated, reducing compliance requirements in operations management. • New jobs and industries emerge, offering vast rewards for the entrepreneurs able to move fast and seize opportunities. • Payroll, taxation and other routine bookkeeping is reformed around automated systems, freeing up time to focus on core business.
Education and Training Providers	• Education becomes truly globalised, the best educators are able to reach students in distant corners of the world. • Certification from leading online institutes has mechanisms for authentication and is accepted globally. • Primary and secondary education is refocused around a digitally interactive experience.
Society	• Excess wealth generated through technologically mediated productivity gains is equitably distributed throughout society. • The cost of healthcare is brought under control, with affordable care remaining available for future generations. • Excess wealth is invested into national infrastructure projects, quality education and training, and secure retirements.

6 TECHNOLOGY AND EMPLOYMENT

Technological change is a major driver of the economic growth which has raised living standards enormously (though unevenly) across the world. However, in the short term it can cause disruption and dislocation for individuals and societies, as previous sources of income or wealth rapidly lose their value. There is a growing fear of 'technological unemployment' as machines become dominant in the economy. Such fears have arisen repeatedly through history in response to new technologies. In the long term, technology has increased the productivity of workers, and driven very substantial increases in living standards, but in the short term it has also led to considerable hardship among the workers it displaces [225].

6.1 Globalisation

Globalisation has been greatly facilitated by digital technologies which reduce the cost of long distance communication. It has resulted in substantial increases in international trade. While trade generates net economic benefits, some industries and workers are vulnerable to cheaper foreign competitors. Relatively high wage countries such as Australia and the USA have seen some domestic industries suffer due to imports from lower cost countries, particularly in Asia. In the US this has been shown to result in both lower wages and reduced workforce participation (and greater uptake of disability benefits) in local labour markets [226].

The manufacturing sector has been particularly impacted by competition from imported goods. Employment in Australian manufacturing has declined by around 150,000 people (about 15 per cent of the total) over the past 20 years, at a time when employment in other sectors has been growing strongly [66]. Technology has also made a growing range of services tradeable. An early example of this was the use of offshore call centres to serve Australian customers. As a relatively high skill, high wage country, Australia is particularly vulnerable to losing jobs offshore as skill levels rise in lower wage countries.

Offshoring does reduce employment in the source country, but has also been shown to increase investment, innovation and wages, particularly among skilled workers [227], [228]. While some local workers are displaced, many others benefit (and of course globally increased trade leads to higher overall employment and income). Further advances in digital technology, along with rising educational attainment across Asia, expand the number of occupations at risk of offshoring. Jobs that involve working with information may not be tied to a particular location; as such jobs become more common in the digital economy, the potential for employment to move within, and between, countries increases.

6.2 Automation

Automation, in which human workers are replaced by machines or computer programs, has many parallels with globalisation in terms of its impacts on local employment. Technology has been able to substitute for workers in a range of routine tasks, which has displaced some occupations entirely, particularly in the middle of the skills and income distribution [229]. It has been argued that automation has resulted in 'middle class' jobs becoming scarcer in the US, which will have profound economic and social implications [60]. Those workers who have skills which are complementary to technology become more productive (and thus command better wages and job opportunities) while those without such skills, or who perform routine tasks, do worse, as they can be replaced by technology [52], [60], [78], [230].

The jobs most susceptible to automation are those that can be considered routine, i.e. follow well defined procedures which are suitable for codifying (e.g. record-keeping, repetitive customer service) [229]. Routine is not the same as mundane [78]: there are many mundane tasks that are likely to defy automation for decades to come (e.g. medical diagnosis, legal writing). However, history suggests one should expect to be surprised by the pace at which technological change can render some tasks routine – the paper [229] which sets out the 'routinization' hypothesis of labour substitution highlights driving as a non-routine task, just a few years before Google demonstrated the driverless car [52], [231]. Even tasks considered highly cognitive, such as scientific research, can already be automated in some circumstances [232].

By breaking jobs down into their component tasks and activities it is possible to estimate how susceptible they are to automation. This was approach was taken in a well-known study from the University of Oxford, which estimated that 47 per cent of US workers were at risk of having their occupations taken over by digital technology in coming years (the timescale was not precisely defined, given the number of uncertainties over technology deployment) [7]. This went beyond existing automation to consider technologies such as machine learning (a field that includes artificial intelligence and pattern recognition), which has the potential to render cognitive tasks just as liable to automation as routine non-cognitive tasks. Applying the same methods to Australia suggests that 44 per cent of existing jobs are at risk of automation [33], [233].

While such estimates of looming job losses certainly attract attention, they are only a part of the jobs and technology story. Technology complements as well as substitutes for human labour, and commentators are prone to overstate the potential substitution and understate the potential complementarity [234]. There are many opportunities for human workers to become more productive by working with new technology [235]. For example, the numbers of bank tellers has declined sharply due to automation, as automated teller machines proved both cheaper and more convenient. However, by making the banking industry more productive technology created opportunities to sell a greater range of services [234].

Figure 36 documents how the number of bank tellers (a relatively low skill occupation) declined by 50,000 in Australia between 1995 and 2005, while at the same time the number of more highly skilled (and paid) finance professionals rose by a similar amount. While technology is not the only driver of these trends, it does show that automation is not inexorably linked to lower employment. Reducing the cost of goods and services is likely to result in an increase in consumer demand (the magnitude of which depends on the price elasticity of demand). Technology can also increase the range of goods and services which can be offered, again increasing overall demand.

Figure 36 Bank tellers and finance professionals

Note that while the number of bank tellers has declined, the numbers of financial brokers, dealers and advisers have risen. Tellers are ANZSCO Bank workers 5521 (skill level 4); professionals include ANZSCO Financial Dealers 2222 (skill level 1), Financial Brokers 2221 (skill level 2) and Financial Investment Advisers and Managers 2223 (skill level 1) [66].

Source: Australian Bureau of Statistics.

6.3 Augmentation

It is therefore important to consider the ways in which technology can augment the value of human labour [235]. By working with technology people can accomplish more. They can access more tools and information, solve more complex problems and spend more of their time on valuable as opposed to mundane tasks. Digital photography provides one example of augmentation. While workers who specialised in developing photographic films were displaced, digital technology has unleashed many photographers (Figure 37), allowing them to do more and at lower cost than they could before.

Figure 37 Jobs in photography

Source: Australian Bureau of Statistics [66]

Another example is the growth of graphic designers in Australia (35,000 over 20 years), while the number of workers in more traditional printing trades has declined (by 17,000) (Figure 38). Again, graphic design is a human skill which has been considerably augmented by digital technology (and many graphic designers probably work exclusively in digital formats). Lower skilled printing jobs have been lost, while higher skilled design jobs have been created. This is an example of skills-biased technical change – new technology creates more opportunities for workers with more skills.

Figure 38 Employment in graphic design and printing

Data source: Australian Bureau of Statistics [66]

Technological augmentation is likely to be a major driver of the increase in skilled employment seen in Australia over the last two decades (the Rising Bar megatrend). While employment at lower skill levels has not shrunk in absolute terms, many occupations, such as printers and developers, have clearly declined. This has created ever more opportunities for skilled employment (jobs which are also likely to be more fulfilling and better paid). However, not all individuals get to enjoy these benefits; it is unlikely that many displaced printing press workers have become graphic designers. Such distributional impacts are discussed in more detail below.

We carried out a detailed analysis on the changing patterns of employment observed in around 350 occupations for which the ABS provides detailed data [66]. We matched each occupation to one or more equivalent occupations in the US Department of Labor O*NET database, which provides breakdowns of the relative importance of 41 different activities in each occupation (see Appendix for methodological details). Statistical learning identified four clusters of activities which best explained changes in employment. One cluster broadly encompassed knowledge work (including getting, documenting and analysing information, creative thinking and problem solving); a second encompassed higher-level people skills (e.g. influencing, negotiating, coaching); the third cluster involved machines and physical work (e.g. maintenance, operation) and the fourth service work (caring, working with the public).

These four groups of activities were used in a statistical analysis of the drivers of employment growth across professions, looking at the Australian data going back to 1991. Occupations in which people skills are important were found to have grown significantly faster than average, adding up to 43 per cent more jobs than the average. By contrast occupations working with machines or doing physical work grew significantly less (up to 55 per cent below the average). Surprisingly, jobs involving knowledge and service activities were no more or less likely than average to grow. Looking at the knowledge activity group in more detail, we found that the highest skill category jobs involving knowledge work had actually grown significantly more than average, while less skilled jobs grew more slowly. This may reflect the automation of 'routine' knowledge work such as clerical and administrative jobs and augmentation occurring at the higher skill levels.

6.4 Distributional impacts

Technology impacts not just the types of jobs demand by the labour market, but also the relative incomes these jobs pay. International evidence suggests that labour markets are polarising, with more workers moving into higher and lower skilled jobs than mid-level jobs since the early 1990s [80]. In the US, the wage advantage enjoyed by more educated workers has increased over the last 30 years, while at the same time low skilled workers have seen their real earnings decline [78]. Furthermore, the decreasing labour share of the national income in Australia, as in most regions of the world, indicates a shift of income from labour (wages and employment growth) to capital [51]. Fuelled by the mining boom, capital income growth accelerated, outperforming growth in employment and real wages [203].

Globalisation has also put downward pressure on wages for less skilled workers in developed economies, though automation appears to be the main driver of job polarisation [79], [236], [237]. Both automation and globalisation can result in increased inequality in developed countries, although offshoring of jobs decreases inequality at the global scale. As population growth slows and populations age, both in developed countries and beyond (notably China), the relative demand for labour may increase, which would go some way to reducing inequality both within and between countries [238].

Many European countries also show evidence of job polarisation, with declines in the middle third of skills distribution [239]. In most of these countries the growth in high skilled jobs has been greater than the growth in low skilled jobs. A key question is to what extent individual workers are able to transition into higher skilled jobs, and how many are left behind by technological change. In the US the shift from medium to high level jobs has been greater for females, with a greater proportion of males being left in low skilled (and low paid) work [78].

Australia has seen no absolute decline in employment at any skill level, though there has been a notable increase in the relative numbers of higher skilled jobs (The Rising Bar Megatrend). And unlike in the US, real incomes have grown across the distribution, rather than just among the highest paid [240]. However, Australian men, particularly single men with less education, are becoming increasingly likely to drop out of the labour force [32], [241] (see Divergent Demographics megatrend). Despite strong jobs growth in the service sector, it appears that for a growing number of men the labour market has little to offer unless they re-train.

In theory automation can, under some circumstances, lower both wages and output, reducing overall welfare: this is less likely if the goods and services produced by automation are not direct substitutes for those produced by humans [242]. A key question is therefore the extent to which people value (and are willing to pay for) human labour compared to its technological alternative. For example, how much do people value personal service over automated systems? Many of us dislike the automated check-outs that have proliferated in our supermarkets, but fewer are willing to pay the cost of a longer wait for a human operator.

The degree to which human service is considered valuable in different contexts will determine how much human service workers can earn, relative to those who own and design the machines. While supermarket check-out operators appear to be losing ground, the rise of personal trainers indicates that people are willing to pay for service in some settings. Similarly, the degree to which people value craft and bespoke design compared with mass production will be important in determining how income is distributed in manufacturing. The music industry gives cause for optimism: despite the ready availability of high definition audio files, live music and the experience it provides is still in high demand, and the number of music professionals has increased since 1992 [66].

6.5 Technology and the firm

Technology is also changing the way businesses are organised, which itself has implications for employment. The very existence of firms is not obvious from basic economic theory, in which individual agents exchange their goods and services through markets. Economist Ronald Coase [243] showed that firms exist to avoid the transaction costs associated with using markets. While in theory every task might be contracted out to the marketplace, in practice there are significant costs associated with finding the right supplier and price, and entering into a contract. This also means that one long contract may be cheaper than several shorter ones, ultimately giving rise to an employment relationship.

Optimal firm size depends on economies of scale. Coase [243] suggested that ICT (he meant the telephone and telegraph!) could reduce the cost of organising spatially, and so increase the optimal size of the firm. The adoption of digital technologies such as the internet indeed coincided with an era of globalisation, in which many firms expanded their size and geographic reach. The structure of firms will also be affected. Hierarchies typically provide a means for analysing and processing information, ensuring that decision-makers only receive the most relevant information [244]. As data collection and analysis tools improve, less hierarchy is required, with networks instead playing a greater role [245]. This clearly has significant implications for jobs in middle management.

The emergence of digital platforms, which bring buyers and sellers together online, has greatly reduced the transaction costs involved in many different types of market transactions. Digital platforms for freelance employment, professional services and even problem solving (Porous Boundaries Megatrend) greatly reduce the transaction costs of using markets rather than internal resources. All other things being equal, this will increase the attractiveness of temporary contracting over ongoing employment for employers. Firms may become smaller in terms of their core staff, and rely on networks of freelancers and service providers to deliver a greater proportion of their work.

Such flexible employment is in theory very attractive to firms. It allows them to respond rapidly to changes in their markets, for example large orders or the need for new products, without needing to maintain a large inventory of staff on the payroll. However, there are likely to be limits to the freelancer model. It is best suited to work which can be clearly measured, for which incentives can be readily aligned to outputs. Where the quantity and quality of work is less easy to observe, employment may need to be internalised within management hierarchies inside firms [246], [247]. A freelance workforce clearly has less invested in the ongoing success of a company which may not produce optimal results.

Freelancers are more likely to seek jobs where they can develop skills that are easily transferable, as they must be continually looking to future jobs. They will be less willing to invest time and effort into developing less transferable skills or knowledge without an ongoing employment relationship. Where such specific skills are important, firms may need to offer ongoing employment to attract good workers. Similarly, where relationships with customers are important, firms may also need longer term relationships with their employees.

As Coase noted, risk preferences also matter. Freelancing is a risky environment compared to ongoing employment. Many workers value job security, so firms may find it worthwhile to offer ongoing employment in order to keep (and motivate) good workers, and many workers may (continue to) trade off pay and conditions for tenure. Freelance employment markets mediated through digital platforms will perhaps make most progress in areas where casual employment is already common, for example through the disintermediation of labour hire companies. Uber is an oft-cited example of casualisation, but few existing taxi drivers in Australia could be classified as employees (they are typically contractors) [248].

6.6 Market structure

For digital goods and services, the marginal costs of production are close to zero, so the returns to scale can be extremely large. This means that large firms could tend to dominate many markets, potentially at the global scale, as they have in-built cost advantages over smaller players. This also contributes to income inequality, as returns to scale magnify small differences in performance, so the rewards for top talent may increase substantially [249]. While those who work in top digital firms may be well paid (particularly those in more important positions), such firms need not necessarily employ large numbers of people.

However, digital technology also opens up many more niches in which individuals and firms might find gainful employment. For example, online distribution allows many more writers and musicians to find audiences, increasing both the diversity and quality of products available [250]–[252]. Despite the well-publicised struggles of the newspaper industry, employment in the 'journalism and other writers' category is trending upwards in Australia [66].

Digital platforms can also overcome the information asymmetry and moral hazard issues which impede many markets [253], allowing a greater diversity of individuals and firms to flourish. For example, online reputation mechanisms, which are an integral part of platforms such as eBay, facilitate the trust required for an enormous range of transactions between complete strangers. There is no better exemplar of the power of such networks than the various incarnations of the 'Silk Road' online marketplace, which specialised in illegal goods: traders clearly had no legal means to recourse, yet the network proved effective, largely due to reputation mechanisms [254].

Online reputations through platforms such as TripAdvisor are increasingly important for business [255], [256], reducing the value of traditional indicators of quality, such as brands. It is therefore likely that independent hotels and restaurants can compete much more effectively against the major chains than they could in the past (though they themselves may be disrupted by networks such as Airbnb). The extent to which markets become fragmented or concentrated in the digital economy will depend on the nature of economies of scale and the degree of heterogeneity in consumer preferences [257].

The digital economy offers greater opportunities for entrepreneurship, as technology allows both more potential innovation and improved networking facilitates access to clients and investors (Era of the Entrepreneur Megatrend). It is becoming easier to build a reputation and make connections, creating a more level playing field for would-be entrepreneurs. This is to be welcomed, as ultimately economic growth depends on innovative entrepreneurs. It also means existing markets will continue to be disrupted, and new markets opened up, as these megatrends unfold.

6.7 Jobs of the future

The Australian Government Department of Employment has detailed forecasts for existing jobs out to 2019. However, technological and demographic change are likely to see the emergence of brand new job types. This section of the report speculates about six new jobs which may emerge given the megatrends and scenarios. There is no statistical or mathematical modelling technique which can be used to forecast jobs of the future with precision. This activity depends, therefore, upon some level of introspection.

6.7.1 BIGGER BIG DATA ANALYSTS

Early sections of this report have documented the explosion of data and information in the online world. According to IBM the world creates an additional 2.5 quintillion bytes of data each year and 90 per cent of the data in existence was created in the last two years [258]. The data is generated from sensory networks, social media uploads, e-commerce records, smartphone geolocation devices and much more. Most of the data is unstructured (videos, photos, text...) and does not adhere to rules or standards of recording for a specific purpose.

However, the amount of structured data is also growing. For example, many governments around the world are embracing the concept of 'open data'. This involves uploading and making publicly available non-sensitive datasets held by public agencies relating to transportation, natural resources, climate, weather and just about anything else. Research is showing that open data initiatives can lead to the development of new products and services which diversify industry, boost economic growth and create new job opportunities [259].

"WE'RE HIRING! I'm looking for senior engineers/ architects for IBM's Analytics Platform team. We've made a big commitment to Apache Spark, and are aggressively executing on a roadmap around this ground-breaking technology. The ideal candidate will have experience in one or more of the following: open-source big data technologies, distributed systems, machine learning, and preferably have an understanding of modern web-based data analytics tools. If you're comfortable crafting complex end-to-end systems on a whiteboard, communicating your ideas with clarity, leading other engineers, and writing world-class code, I'd love to hear from you. Location: San Francisco or San Jose, you choose!"

– From the Public Linked-In Profile on 4 Nov 2015 for Anjul Bhambhri, Vice President, Big Data Analytics at IBM.

As governments and companies turn to vast quantities of data in search of useful information, a new workforce is required. According to an article in *Forbes* (Tech) magazine [260], reporting data from consulting firm WANTED Analytics, IBM alone advertised 2,307 new big data analyst jobs in 2014-15. Anjul Bhambhri is vice president of big data products at IBM. She says, "A data scientist is somebody who is inquisitive, who can stare at data and spot trends. It's almost like a Renaissance individual who really wants to learn and bring change to an organization" [261]. The data from WANTED Analytics show that big data analyst roles typically take 47 days to fill and are rated at 72/100 in recruitment difficulty to fill (where a zero is easiest to recruit and 100 is hardest).

Recent years have seen growth in the number of, and salaries paid to, big data analysts. There has been particularly strong growth in big data analysts working in the area of cybersecurity. Arguably the 'big data analyst' job is already firmly established. However, the decades which lie ahead are likely to lead to more specialisation within the big data analysis profession. There are likely to be big data specialists who have skills in machine learning, automation, cyber security, encryption and distributed (cloud based) systems. It is also likely that big data analysts with sectoral domain expertise will emerge in health, transport, urban design, retail and many other sectors.

6.7.2 COMPLEX DECISION SUPPORT ANALYSTS

Decision support analysts work in many different fields to help people maker wiser choices. Their roles involve analysing and interpreting information to identify options and advise their organisations about which ones to implement. The job of 'decision support analyst' isn't new. However, this role is likely to grow in prominence and redefine itself due to two drivers: (a) the shift from 'big data' to 'big decisions' and (b) the explosion of choice in an online and globally connected economy. Automation and artificial intelligence is also likely to shift the emphasis onto fuzzy, ill-structured and complex decision problems (tactical and strategic) and away from highly rules-based (operational) decisions.

The 'big data' phenomenon is increasingly being recast as a 'big decisions' phenomenon [262]. This is because having lots of data, or even lots of useful information, is a stepping stone to what really matters; the operational and strategic choices made by organisational leaders. While decision makers of the future may be armed with more information, the choices they make are likely to hold larger consequences for shareholders and society. This is the inevitable consequence of growth. The stakes in decision-making will be higher as corporate acquisitions, supply chains, regional populations and market capitalisations all increase. Decisions of the future will also be more complex. They are likely to involve more stakeholders (with more perspective) and in a more complex regulatory environment to account for multiple objectives (e.g. social, environmental, financial, technological). All of this calls for greater skill and effort in decision making.

The other driving force is associated with an explosion of choices in the digitally connected and online world economy. Options once hidden from view are now visible, and part of the selection set. Consumers, procurement specialists, recruitment agencies, stockbrokers, investment bankers and many others need to entertain more options which pass the initial screen. In a world of few options 'analysis paralysis' was a niche issue. But in today's world, with so many choices about everything, analysis paralysis is a mainstream dilemma. Psychologists and management scientists have identified the 'paradox of choice' phenomenon [263] in which too many options overwhelm (and often demotivate) a decision-maker, leading to inaction and even unhappiness.

Decision support analysts of the future will increasingly be concerned with solving tactical and strategic choice problems. Whilst an understanding of routine financial calculations (e.g. calculating net present values and internal rates of return) will be important, many of these tasks will be automated. The weight and emphasis will fall onto the non-routine aspects of the job. The ability to turn fuzzy, messy, complex, multi-objective and multi-stakeholder issues into structured decision problems with a manageable and finite set of options will be highly prized. Algorithms will often quickly identify the best-performing option, with minimal human intervention, once the decision problem is structured. The human input will be focused on creating structure.

6.7.3 REMOTE CONTROLLED VEHICLE OPERATORS

The rise of un-crewed vehicles (UVs) is giving rise to a new workforce of pilots, drivers and ship captains who do their jobs not from the sky, sea or mine site, but from an office in a remote location. This has been accompanied by growth of a training industry focused on developing the new skills in remote controlled device operation. While UVs require many of the skills needed to operate the vehicle in the real world via conventional means they also require new and different skills with changed emphasis.

> "As a UAV Operator (ECN 250), you'll operate a UAV to be the eyes and ears of the battlefield. It's an exciting and rewarding job, as the information you gather will be used to keep the troops on the ground safe and up to date on the enemy threat in their area.... You'll be trained on the theory of flight and how to identify weather conditions that affect your ability to fly. You'll be trained to work as part of a crew to operate the surveillance suite (cameras both day and night) and control the aircraft in flight".
>
> – Extract from a job advertisement on www.defencejobs.gov.au for the Australian Army (viewed 4 November 2015).

For example, in late 2013 the Civil Aviation Safety Authority of Australia (CASA) approved Remotely Piloted Aircraft System (RPAS) training syllabus with both theoretical and practical content. This includes generic aeronautical skills and knowledge (e.g. navigation, meteorology) but also specific material relating to the remote control of an aerial vehicle (e.g. pre-flight checks, standard procedures). According to ACUO, by the end of 2015, there are likely to be 'at least a dozen or more' certified RPAS training schools producing RPAS accredited graduates in Australia [264].

Continued growth in training organisations and qualified RPAS pilots is likely to increase in the future. The number of businesses applying for a CASA drone licence has risen from 14 in 2012 to over 180 licences today [265]. The applications of UVs are increasingly varied. They are used heavily in defence (air force, navy and army) but also in agriculture, construction, photography, mining, transport, law enforcement and emergency services. In a review of unmanned aerial vehicles CASA notes: "More than 650 applications for remotely piloted aircraft have been identified. Most of these can be categorised as 'dull, dirty, dangerous and demanding,' and are tasks that a remotely piloted aircraft can do best because it does not put its pilot at risk" [266].

The next 20 years are likely to see the jobs of remote controlled vehicle operators grow in number and diversity of tasks as the military and civilian fleets of aircraft, boats and ground vehicles expand. It is likely that automation will play a greater role in improving the efficiency and safety of unmanned systems but they will most likely be controlled by humans for the foreseeable future. The systems need to identify, diagnose and respond to many non-routine situations which require human judgement.

6.7.4 CUSTOMER EXPERIENCE EXPERTS

There will be no necessity to visit the shop of the future, as the ever more ubiquitous online offering will win (or break even) in terms of price, product range, quality and convenience. Similarly there will be no need to visit the office of the future, as hyper-connected virtual workspaces will allow the majority of knowledge and service sector workers to do their job from anywhere.

However, people will still visit the physical shop and office of the future because of the all-important experience-factor. The ability to hear, touch, feel, smell products and the physical environment and, perhaps most importantly, the ability to have social interaction with other people, are desirable qualities derived from their contrast with the increasing penetration of digital technologies. As people become immersed in the virtual world the marginal value of the physical world will grow. If shops, offices, museums, theatres, libraries, city centres and many other public spaces understand and deliver on the all-important experience factor they'll continue to grow into the future. That will require dedicated staff and expertise.

The ranks of the CEO, COO, CIO and CTO (and their many support staff) may soon be complemented by the CXO and the CCO; namely the chief experience officer and the chief customer officer. An article in the Harvard Business Review [267] suggests the CCO or CXO position are part of a broader imperative around creating a customer-centred organisation. This analysis says that CCOs and CXOs "serve as top executives with the mandate and power to design, orchestrate, and improve customer experiences across the ever-more-complex range of customer interactions. The role exists in B2B and B2C firms as diverse as Allstate, Dunkin' Brands, USAA, Philips Electronics, FedEx, the Cleveland Clinic, and SAP" [267].

It is unlikely that the CCO and CXO jobs will exist in isolation. They are likely to be accompanied by teams of staff with skills in psychology, marketing, design and a depth of understanding about what customers and society really want. They will also need the skills to insert their ideas into every part of the business, to ensure the experiences are delivered across multi-channels (physical and virtual).

What do these jobs look like in the future? Imagine a supermarket of 2035. The background supply chains have become so quick and efficient that hardly anything is actually purchased instore, but delivered via speedy courier and arrives home before the customer does. The supermarket has not disappeared, but become a showroom, with advisors and consultants seated at desks advising coffee-sipping customers about the merits of food, clothing and household products, based on their health and lifestyle needs.

An article in the Sydney Morning Herald dated 21 July 2015 by Karl Quinn describes the appointment of Seb Chan as the first Chief Experience Officer (CXO) at the Australian Centre for the Moving Image (ACMI). In the article the ACMI CEO Katrina Sedgwick who created the position says "We're pushing to get ahead of the curve ... It's not necessarily about increasing visitor numbers [ACMI is one of the most visited galleries in the country, with 1.143 million visitors in 2014-15], it's about enhancing and enriching the experience... I'm really keen to ramp up the museum as a social place ... In the end, it's about inspiring conversations and ideas."

If this happens the supermarket of the year 2035 has become a lifestyle and learning environment. The CCOs and CXOs (and their departments) have removed all of the annoying and unpleasant aspects of shopping (e.g. finding a park, getting a trolley, finding the toothpaste...) and have delivered on experiential goods (e.g. learning about how to make an authentic Valencian paella and whether or not red wine is actually good or bad for health and in what quantity).

To achieve transitions of this nature, supermarkets, shopping malls, hardware stores, banks, hospitals and many other service oriented organisations will have employed a workforce of creative, imaginative and perceptive customer experience experts.

6.7.5 PERSONALISED PREVENTATIVE HEALTH HELPERS

This new job category encompasses workers who possess great 'people skills' and have the ability to understand and interpret health/wellbeing related scientific information. They will help their clients avoid chronic and diet-related illness, improve cognitive function, achieve improved mental health and achieve improved lifestyles overall. They will make use of information technology and provide personalised support/guidance to a number of clients and maintain close contact over time. The recent trends in personal fitness trainers provide some insight to how this profession may expand, diversify and develop over the coming decades.

The last ten years have seen an explosion in the number of personal trainers working to help people achieve health and fitness targets. According to a report by IBISWorld the industry grew 5.3 percent over the five years leading up to 2012. Today there are 6,355 personal training businesses in Australia with 35 percent in Victoria, 28 percent in Queensland, 23 percent in New South Wales and the remainder in other states and territories. A 2011 survey by Sportspeople found annual average income for a personal trainer (many of whom work part time) at $45,554. The industry is expected to continue growing, albeit at a slower pace in future [268].

The rise of personal trainers has also happened in other parts of the world. The United States Bureau of Labour Statistics (BLS) estimated some 267,000 people were working as personal trainers in 2012, earning an average hourly wage of $US15.25 and average annual wage of $31,720. The number of personal trainers is expected to grow by 13 per cent to 33,500 people, by 2022. The entry level qualification is a high school diploma or equivalent with short-term on the job training. The BLS defines the purpose of fitness trainers and instructors as being to "lead, instruct, and motivate individuals or groups in exercise activities" [269].

The personal fitness trainer can be considered an existing job with a trajectory of growth; albeit at slower rates than in recent years. There is a plausible future where the success of personal training for fitness is replicated in other areas relating to physical/mental health and broader lifestyle assistance. Whether they are called lifestyle coaches or personal wellbeing managers, these professionals will work with individuals to improve broader mental, physical health and wellbeing.

One of the main drivers for the demand for these skills is the rise of diet-related illness (e.g. cardiovascular, diabetes, neurological ...). A study published in the *Medical Journal of Australia* [270] finds annual average healthcare costs of $A2,788 for people with obesity (measured via body mass index or waist circumference). This is almost double the cost of $1,472 for someone within the normal weight range. Despite the benefits of better diet, and the mounting scientific evidence, long term changes in eating patterns have been hard to achieve. The financial cost of chronic illness alone, without consideration of the personal non-financial cost, justifies expenditure by individuals and society on improved diets.

Another driving force creating increased demand is the growing awareness of mental health and wellbeing issues. Mental health covers a spectrum from wellbeing, where people are flourishing, to languishing in their daily lives, through to mental illness, where people have a diagnosable disorder of some type. According to the Australian Institute of Health and Welfare, 45 per cent of Australians experience a mental disorder at some time in their life and 20 percent of Australians have experienced at least a common mental disorder in the last year [271]. All Australians vary on the wellbeing scale (languishing to flourishing) to some extent during their lives. The links between mental health and lifestyle patterns and events (e.g. sleep, stress, trauma substance abuse) are well established. As science discovers more about mental health, personal trainers of the future may become focused on helping people to adopt lifestyle patterns conducive to good mental health.

The last force fuelling demand for preventative health helpers is the potential strong benefit cost ratios of preventative health programs. Many developed countries are experiencing rapid, and arguably unsustainable, escalation of healthcare costs. A recent study in the United States finds that a package of 20 preventative health programs would deliver $US3.7 billion in net financial savings and avert the loss of more than two million lives annually [272]. Other research is more circumspect about the benefits of prevention, but still identifies many cases where it provides strong positive financial returns [273].

On balance, preventative health would seem to hold much scope for reducing disease prevalence rates and reducing healthcare costs. In theory strong and untapped investment returns should be associated with increased investment, and jobs, in supplying the preventative health services.

6.7.6 ONLINE CHAPERONES

Online chaperones will work for individuals and small businesses to protect and manage their online interests. They will have skills in managing risks such as identity theft, reputational damage, social media bullying and harassment and internet fraud. The demand for these skills is fuelled from increased risks associated with e-commerce, social media and internet use in general. Every year the quantity, diversity and impact of cyber threats increases. The Australian Government reports that 5 million Australians fall victim to cybercrime per year and 60 percent of Australians have been victimised at some point during their life.

Concerns about cyberbullying and harassment and the disclosure of personal information online are also rising. A survey of 3000 students from years 6 to year 12 across Australia found that 14 per cent experienced cyber-bullying in the past 12 months and that 54 percent “worry about someone hacking into their page on a social networking website” [274].

Law enforcement agencies may struggle to provide sufficient protection, and individuals and companies are likely to search for additional support. The likelihood of further growth in the cybersecurity profession is high. The United Stated BLS identifies a workforce of some 75,100 ‘information security analysts’ in the United States today, with growth of 37 percent per annum; a growth rate much faster than the economy-wide average. The entry level qualification is a bachelor’s degree, and the median pay is $US86 170 per year or $US41.43 per hour, also well above the median wage rate.

The cybersecurity professional is likely to be accompanied by professionals, with expertise in the management of online identities and social media, who protect people’s interests. These professionals will have the capacity for rapid response and online support above and beyond the scope of government and law enforcement agencies. They may form trusted and long term relationships with their clients as do lawyers and doctors.

7 POLICY IMPLICATIONS

Technological progress will create many new, exciting and well-paid jobs for Australian workers. It will change models of work, giving employees more flexibility and more options. Technology will also improve the productivity of industry and boost economic growth, household income and quality of life. Technological progress will happen against a backdrop of demographic change, globalisation and a shift into platform economics.

However, the change which lies ahead will also create significant challenges and have uneven impacts across society. Many Australians, especially unskilled workers, are likely to struggle with the degree of change forecast in this report. Some individuals in sectors and locations that experience a high degree of disruption may experience serious social consequences, including unemployment, financial hardship and marginalisation. How Australia's workforce fares in the long term will depend on our ability to help workers make transitions to new and better jobs.

While this report does not make policy recommendations, it does explore implications of the megatrends and scenarios for companies, governments and communities in the remainder of this section. These are areas where targeted actions are likely to improve the outcomes for Australian workers and companies in managing workplace transitions.

7.1 Digital inclusion

Although digital technology is playing an ever-increasing role in the way in which we work and live, there are still nearly four million householders without access to the internet [275]. Furthermore, lack of knowledge and skills, and lacking an understanding the benefits appear to be the most important barriers to internet use among Australian householders [276]. Achieving digital inclusion (ensuring that everyone has the knowledge, resources and skills to use the internet in ways of value to them) will be an important first step towards transitioning everyone to the future digital economy and society.

In the United Kingdom, the Tinder Foundation has launched Reboot UK, a £330 000 project that will develop and test innovative new models for building digital skills and supporting social outcomes for people in poverty [277]. In Australia, Infoxchange (funded by Australia Post) recently launched a national digital inclusion initiative to improve digital literacy among relatively digitally excluded groups, such as small businesses owners and Indigenous people [278].

The findings from initiatives such as these are likely to be useful in understanding how to support the most excluded groups in remaining connected and participating in the digital economy and society. There may also be a case for targeting social housing communities through digital inclusion efforts: these communities represent 'hot spots' of digital exclusion and economies of scale can be achieved by connecting many individuals at a shared location [279]. An evaluation of one Australian social housing digital inclusion initiative found that the initiative was associated with improved employment outcomes for residents [280].

7.2 Empowering and informing labour market re-activation

Beyond ensuring that all Australians have both the skills and the resources to use the internet, the effect of digital disruption on jobs and businesses will create a need for targeted labour market re-activation programs. Analysis of labour market pathways has revealed that Australian workers are relatively immobile, commonly spending long periods of time in one occupation [281]. Furthermore, analysis of previous responses to regional employment shock (the corporate failure of Ansett Airlines in 2001 which resulted in the loss of approximately 20,000 jobs nationwide) reveals that the employers in areas where jobs were available tended to select younger skilled workers for jobs [282]. Those older and less skilled workers who were not offered jobs tended to shift to less costly housing in their existing region (where future employment opportunities were restricted) rather than making a speculative move to a location where there was growth in employment opportunities in the hope of finding another job once they got there [282]. This research suggests that future digital disruption, which is likely to be geographically concentrated, has the potential to exacerbate existing regional inequalities.

One means of empowering the individuals affected by digital disruption and the service providers who are responsible for supporting them is to provide up-to-date information about demand and supply for labour and specific skill sets. Big data analytics offer the potential to model workforce deployment for the whole economy in a cost effective and timely manner. Furthermore, by modelling career pathways and outcomes over time, there is potential to identify factors most consistently associated with successful career transitions in response to digital disruption (e.g. training investments, financial resources, access to technology) and importantly, the characteristics (e.g. education level, industry sector, geographic location, age) which moderate the effect of these factors. The analysis of labour market transitions carried out by the Productivity Commission [48] shows how sequential pathways can be delineated for specific population groups and related to more or less successful labour market outcomes. However, to inform individual career choices in the fast-changing digital economy, more real-time and fine-grained modelling, drawing upon holistic and dynamic data, will be required.

Since older, unskilled male workers appear to be already experiencing disruption (due to the shift away from manufacturing and into service delivery) it may be useful to focus initially on labour market transitions within this population (e.g. with the cessation of car manufacturing and the downturn in mining) towards identifying those resources and initiatives that are most successful in helping these workers transition to alternative long-term and meaningful employment. Importantly, analysis of the longer-term and spatial impacts associated with the MG Rover factory closure in the UK revealed that long-term unemployment in the area remained higher even after the majority of the displaced workers had found re-employment, presumably because of the increased competition in the labour market created by the displaced factory workers [283]. This research implies that redeployment efforts need to be targeted at the community level, rather than focused on those workers who are immediately made redundant, since the long term impacts of large-scale loss of employment may be felt by other, less qualified workers in those local communities[283]. Research also finds that labour market re-activation initiatives are more effective when they empower participants [284] and give participants choice, voice and individualised pathways [285]–[287].

7.3 New workforce statistics

To inform investment decisions (e.g. capital, education, redeployment of workers) in a continually changing environment, it is essential to have good measures and data. Much of the value delivered by the digital economy is not captured by traditional measures such as GDP. For example, the value of having 24-hr at home access to online government services is not captured by official statistics, even though the cost of developing and maintaining the new online services is represented in current statistics. A recent analysis of statistical measures needed for the digital economy [288] suggests that priority should be given to (1) productivity, living standards and wellbeing indicators, (2) labour markets and income distribution and (3) the way in which production is organised.

The OECD [289] has begun to experiment with new indicators for the digital economy and is continuing to develop measures and models that capture value in a digital economy will be critical in order to understand how we are progressing in the dynamic world of the global digital economy. Our own research for this report points to the need for new employment categorisations which assist in differentiating freelance workers and entrepreneurial businesses from traditional small businesses.

As noted above, social media, open government data, sensor technology and the growth of the Internet of Things provide new measures and analytics to inform our understanding of the digital economy and society. However, there will be ethical and regulatory issues to resolve before the potential of big data can be realised [290].

7.4 Education

Education is likely to be one of the most critical factors shaping workforce outcomes in the future. The research not only suggests that most of the new jobs of the future will require high levels of skills but also that continual investment in education will be required in order to keep up with the rate of change brought about by developments in digital technology. Thus, lifelong learning (and importantly, appropriately targeted learning) will be important in order to secure the productive and well-paid jobs of the future. The educational sector might need to work in close collaboration with business and industrial organisations as well as governments to ensure educational programs are developed in accordance with future employees' needs.

7.4.1 DEVELOP SKILLS AND APTITUDES FOR TOMORROW'S JOBS

The current education system teaches people to be effective in a highly structured system, but Australia's future workforce is likely to encounter much ambiguity and openness [291]. For this reason, commentators argue that our future educational system will need to do more to encourage innovative, entrepreneurial and flexible mindsets. As one example of this type of approach, in Iceland, 'Innovation Education' was included in the national curriculum in 2007. Through Innovation Education, students are taught to identify problems and needs in their environment and then research the knowledge to develop a solution to the problem [292]. This addition to the curriculum does not appear to have been evaluated systematically so far, but is reported to promote not only innovative thinking but also ethical maturation and social responsibility [292].

There is potential to achieve significant cost efficiencies in education by reducing the duplication of effort involved in generating teaching material, then dedicating resources towards those aspects of learning that benefit from being localised or delivered face to face. Already, some efficiencies are being achieved through the use of digital learning resources. The National Digital Learning Resources Network (NDLRN) offers free digital teaching resources aligned with the Australian, state and territory curricula. These have been accessed by over one third of the teachers in Australian schools [293]. However, these digital learning resources are still delivered by teachers in traditional classroom environments.

In the tertiary sector, Massive Open Online Courses (MOOCs) such as Coursera offer free access to higher education by delivering all course material online. To date, these fully digital learning environments have achieved very low student retention rates [294]. Thus, the integration of digital learning resources into traditional education systems will need to be informed by a better understanding of when, where and how individualised teaching, face to face interaction and co-curricular aspects of campus life add value to online teaching resources.

7.4.2 WORKPLACE AND LIFE LONG LEARNING

Dedicated educational institutions may not have sufficient resources to meet the future need for re-skilling and training. Although apprenticeships have become less popular in recent times, the demand for lifelong learning in the digital economy may lead to a renewed focus on workplace learning. Mobile technology provides a new channel for workplace learning, allowing workers to access training materials and information on the job and when they need it [295]. The field of mobile learning is nascent, but seems well-suited to the needs of a more mobile workforce. Because it can be accessed and applied immediately it has the potential to support higher learning outcomes.

7.4.3 INVESTING IN THE RIGHT SKILLS

Whether or not employers play a larger part in delivering education in the future, stronger connections between education providers and employers are likely to be important to ensure that educational offerings stay relevant [296]. The current youth unemployment crisis can be viewed as a sign that training providers are not providing new workforce entrants with skill sets that are sought after in the current labour market. How we educate is important, but it is also important that we invest in the skills and competencies likely to be required in the future. Individuals who need to re-skill or who are making important educational investments need to understand where there is demand for workers, the type of skills required for these jobs and the income earning potential associated with these jobs. While STEM skills will certainly be in demand, current concerns about the participation in STEM might require some effort from decision makers and educators to make STEM subjects attractive to current and future students, especially females, and integrate them in a wider curriculum for all levels of education.

Aside from core STEM knowledge and skills, our aging population means that the healthcare and aged care sectors will be the largest employers and thus most workers will need some hybrid of technical, business, creative and interpersonal skills. Although development of 'soft' skills in students is on the agenda of some tertiary education providers today, development and integration of specific programs in collaboration with employers might still be needed to ensure graduates are prepared for future workplace needs.

7.5 Workplace relations

7.5.1 FLEXIBILITY AND UNCERTAINTY

While digital technology enables new, more flexible ways of working, flexibility can also be associated with uncertainty and precariousness. The growth of the independent workforce has benefits for employers, who can save costs associated with paying mandated contributions to superannuation, payroll tax, sick leave and vacation time [297], although higher rates can be associated with payments to contractors. Employers can benefit from the flexibility of employing workers for variable tasks or one-off jobs without the obligations of ongoing employment. However, employers might also face intangible costs associated with flexible staff members who lack of knowledge of and interest in company operations, or corporate memory. Knowledge, expertise and experience are forms of intellectual capital that can also be lost.

At the same time, freelance workers have very different bargaining powers with employers when compared with traditional employees, who can act through the Fair Work system. On the one hand, freelancers might have limited leverage in collecting unpaid fees, but they can gain leverage through the ability to withhold their labour or final product. New digital platforms can provide support to freelance workers (e.g. by assisting workers to create contracts and holding funds for payment in escrow). Governments are taking different approaches to address the emerging issues raised by the quickly evolving nature of the organisation of work. This may involve looking at the relevant regulatory and legal frameworks, so as to ensure that these workers can access the rights and working conditions that attach to workers under more traditional employment models [297]. Further complicating this challenge is the global nature of future employment. How do governments protect working conditions for citizens living in Australia but (enabled by digital technology) working for an employer located overseas?

Entrepreneurs represent another type of worker that will play an increasingly important role in the digital economy. However, the high failure rate associated with start-ups can have financial, social and psychological impacts, not only for the entrepreneur but also his or her family, funding partners and employees. Although there is much discussion of the need for venture capital and new regulation to enable business start-ups, the stringency of bankruptcy laws and social attitudes (e.g. stigma attached to business failure) also play a part in the experience of entrepreneurs [298]. Recognising that many would-be entrepreneurs do not start a company because of their fear of the consequences of business failure, the European Commission has introduced a 'second chance' policy, designed to create more conducive conditions for entrepreneurs. The policy includes support systems to prevent bankruptcy, and, when bankruptcy cannot be avoided, automatic discharge and debt settlement within three years [299]. The Australian National Innovation and Science Agenda is looking to reward risk taking by investing in innovation and entrepreneurship, introducing new tax-offsets and changing the default bankruptcy periods [300], [301]

A final issue, associated with portfolio employment as well as independent workers, is how a worker's career development is funded and managed. The more temporary nature of future employment arrangements might decrease the incentives for some employers to invest in workforce development. Well-paid workers may be able to invest in their ongoing skills and professional development. However, in a competitive global economy, some independent workers will struggle to earn enough money to take time out and pay for professional development activity in addition to their normal living expenses. While cost-effective online training offers one solution for these workers, hubs and co-working arrangements may also be an important source of learning opportunities, giving independent workers access to both social support and broader expertise and experience [302].

Overall, flexibility of portfolio employment offers new ways of work for business and individuals, but it comes at a cost of uncertainty. Digital technology will continue changing workplace structures, operations and relations. Existing regulations, laws and policies will have to be adjusted and keep pace with the changing working conditions and emerging issues.

7.5.2 PRIVACY AND SECURITY

Concerns about privacy and security of data are already here today. The media regularly report about new cases of databases leakage and hacked computer systems [303]. Exponentially increasing amount of data, the emergence of the Internet of Things, further growth of global Internet based networks, companies and services (e.g. Amazon, Apple, Google, Facebook etc.) will be increase the number and diversity of privacy problems and concerns. The connected world of tomorrow is also very likely to face considerable acceleration of the security concerns.

As demonstrated in the scenarios above (scenario 3 – Rivers, section 5) cybercrime and privacy concerns may act as blockages to automation. Although technological change is inevitable, it might still be more cost efficient to employ people rather than deal with complex management systems to ensure privacy and security issues are resolved.

Governments are becoming increasingly aware of these issues, and offer tools and advice on online safety [304], but they are likely to need a system of policies to proactively address the privacy and security concerns [303] in the complex cyber-world, and ensure consumer and producer rights are preserved. Governments play dual roles – looking to protect their own information as well as setting the scenes and regulations for business and individuals to operate in.

7.6 The need for choices

There are likely to be many other implications arising from the megatrends and scenarios in this report relating to regions, professions, industries, demographics and so forth. The overarching implication is that, unlike the industrial revolution of the 18th and 19th centuries, as we enter the information revolution of the 21st century we are better informed and better placed to make decisions about the workforce we want to create.

The emergence of the new age of digital and information will imply a change for individuals and organisations. Society, governments and industry can choose how they respond to many of the impacts foreseen in this report. Whether it will be a pro-active, well prepared response or a reactive adjustment is a matter of choice. Exponential technologies have the potential to vastly improve the productivity of individual human workers, deliver services much more cost effectively, and produce goods and energy at very low cost [305]. Even if not everyone will be able to be employed in the future, there will need to be a means of ensuring that people have access to some form of income so that consumption, savings and investment are maintained [306].

We might choose to use the high productivity of a much smaller workforce to provide a minimum basic income for those without jobs. Alternatively, we might choose to maintain higher employment by creating new jobs in areas that are not currently funded, such as taking care of children and old people, health and environment, city infrastructure, and community development.

Given the very political nature of these choices, it will be vital to ensure that all stakeholders have a voice in the decisions that lie ahead. New technologies and new platforms can transform the productivity of Australia's workforce and create new, exciting and well-paid jobs. Strategic foresight and proactive actions will help ensure we harness the opportunities and manage the risks.

FREE
WiFi>
>network: Piccante.
>password: rizzledizzle
All you have to do is
stay on task, kids.

8 CONCLUSION

As the Australian economy continues to evolve, we are seeing shifting patterns of employment across different industries. There have been steady declines in agriculture and manufacturing jobs over the last 20 years, while service industries such as healthcare and professional services have shown strong growth. With the mining boom now well and truly over, real wage growth has slowed, unemployment has risen and the economy must find new sources of growth. Globalisation means that Australian workers face increasing competition from overseas workers, and the forces that have impacted Australian manufacturing jobs will be felt more widely across the economy in the future. Changing demographics, technology advances, platform economics, emerging economies and globalisation are creating a 'perfect storm' for jobs and employment in Australia.

Meanwhile technology is changing the world of work at an ever-faster rate. Some jobs have been automated, and more will be over coming years, but technology is also creating new opportunities. Working with technology, people can do ever more things ever more efficiently, and we have seen strong growth in skilled employment. For those with the right skills and aptitudes (not just technical but also interpersonal), the prospects for meaningful employment have never been better. Job tasks that involve creativity, complex judgement, advanced reasoning, social interaction and emotional intelligence are beyond the reach of even the most advanced artificial intelligence and automation. Jobs that place emphasis on these tasks are likely to experience growth in the decades ahead. Jobs that involve repetitive, rules-based, structured and routine tasks (either manual or cognitive) are at risk of being replaced by automated systems and/or offshoring.

The extent and reach of task automation in the future is a key uncertainty. However, all scenarios identified in this study describe a future with more task automation than today. The transition is likely to happen. The challenge for society is making it happen smoothly and evenly. In general, the question is not whether (or not) jobs will change but how they transition smoothly to new (and better) jobs. Forecasting models or systems which identify the risk of computerisation and feasible pathways to another job for individuals, professions, industries and regions may provide a powerful mechanism for proactive planning and managed transitions. Workers who have time, and options, to plan for change are likely to secure better outcomes.

Digital technology is also revolutionising how, and where, we work. Seamless communication breaks down geographic barriers. This offers knowledge workers flexibility in where and how they do their work, but exposes them to global competition. Digital technology is breaking down other barriers. Disciplinary and professional boundaries are increasingly being blurred as expertise in one field is often proving more powerful when mixed with expertise from another. The disruption also extends beyond individual workers to the organisations within which they work. Digital platforms allow even the smallest players to access large amounts of information and build reputations and networks, reducing the power of incumbency. It is now much easier for people to find freelance work, potentially across multiple jobs. And technology is both increasing the possibilities for, and reducing the barriers to, entrepreneurship. The era of platform economics has begun, and this new paradigm is set to reshape models of wealth generation and employment.

While in theory such flexibility can only enhance economic efficiency, in practice it is likely to be resisted by many workers. It inevitably brings risk and uncertainty which may exacerbate already worryingly high rates of stress and mental illness in the workforce, as well as social issues such as violence, crime, family break ups. While some skilled workers will continue to do better, many other are likely to experience a reduction in status. Rising inequality is not inevitable – societies can and do regulate employment conditions and redistribute income. Australia's response will be constrained by the global nature of the digital economy. Digital technology has the capacity to break down the barriers to labour market entry and may allow many Australians to access exciting new job opportunities. However, it can also have a wealth concentration effect, because computers can allow fewer people to be more productive and achieve greater output. The distributional aspects of labour market transitions will require consideration alongside the productivity and efficiency aspects.

As often happens, it is the youngest generation of workers who will find themselves on the frontline. Those of us in established jobs are less likely to be directly impacted: for cultural and legal reasons employment conditions tend to change slowly. However, new entrants to the labour market and those older workers unfortunate enough to lose their jobs may find it harder to secure ongoing employment. Rates of both unemployment and casual employment have increased notably for young people, and ever more qualifications and experience are needed to secure good jobs. Meanwhile many older workers are willing and able to work past traditional retirement ages, though this is more applicable to knowledge workers than those remaining in manual occupations. Retirement models clearly need to adjust to better allow for gradual winding down of work.

The demographics of participation are changing in other ways. Female workforce participation has increased strongly in recent decades. The knowledge economy should offer more opportunities for career flexibility, which can clearly be beneficial for women who have children, but should also offer men the opportunity to play a more active role in childcare. Male workforce participation is in decline, but not primarily because men are taking on more family responsibilities. There is a notable and concerning upward trend in the number of lower skilled (and often single) males who are dropping out of the workforce entirely. This may be because employment has declined in industries with high male participation rates, such as manufacturing, agriculture and (more recently) mining. Prolonged non-participation has damaging consequences for individuals, families and communities, and represents a lost economic resource, so the reversal of this trend should be a national priority.

Governments, communities and industry all have a role to play in helping vulnerable demographics transition into productive and meaningful work. Some cultural adjustment may be needed to support increased male participation rates in those rapidly growing sources of low to medium skilled employment in the service sector which have traditionally had higher rates of female participation.

The Australian economy will continue to offer excellent work opportunities, particularly for those with the right skills and aptitudes. However, individuals and societies will need to be adaptable, resilient and agile in order to thrive in the digital economy. Workers will need more skills than ever, and will need to work well with both technology and people to create the most value. They will need to work for longer and in a more rapidly changing environment, so skills will need to be continually updated. Our cultural values, expectations and regulations will also need updating to accommodate the new reality. Unlike previous great disruptions, there is now much we can do to foresee the opportunities, and forestall the threats. We hope this work can help inform how Australia adapts and responds to the changing world of work.

REFERENCES

[1] Intel, *A Guide to the Internet of Things*. Intel Website (www.intel.com), 2015.

[2] ITU, *Measuring the Information Society Report*. International Telecommunication Union, 2014.

[3] ACMA, *Australians get mobile*. Australian Communications and Media Authority, 2015.

[4] A. Woodie, "When Big Data Becomes Too Much Data," *Datanami*, no. October, 27 2014, 2014.

[5] ABS, *Internet Activity, Australia. Catalogue Number 8153.0*. Canberra: Australian Bureau of Statistics, 2015.

[6] McKinsey, *The next frontier for innovation*. Competition and Productivity, McKinsey Global Institute, 2011.

[7] C. B. Frey and M. A. Osborne, *The future of employment: How susceptible are jobs to computerisation?* Oxford, United Kingdom: Department of Engineering Science, University of Oxford, 2013.

[8] E. Berland, "Freelancing in America: A national survey of the new workforce," *Freel. Union Elance-oDesk*, 2014.

[9] B. Matthews, *Freelance Statistics 2015: The Freelance Economy in Numbers*. BenRMatthews Website (benrmatthews.com), 2014.

[10] Freelancer.com, *Freelancer.com About*, no. 26.10.2015. Freelancer.com Website, 2015.

[11] Emergent Research, *Online Survey of 1186 Freelancers - May 14-28, 2014*. Emergent Research, 2014.

[12] Deskmag, *Desmag's 2nd Annual Global Coworking Survey*. Deskmag Website (www.deskmag.com), 2012.

[13] PCoA, *Office Vacancy*. Property Council of Australia, 2015.

[14] Upwork, *About Us*. Upwork Global Inc, 2015.

[15] E. Pofeldt, "Elance-oDesk Becomes 'Upwork' In Push To Build $10B In Freelancer Revenues," *Forbes*, 2015.

[16] J. Owyang, "Quick Guide: The Collaborative Economy Body of Work for Corporations (Updated June 2015).," *Collab. Econ. Crowd Companies.*, 2013.

[17] ABS, *Counts of Australian Businesses, including entries and exits. Catalogue Number 8165.0*. Canberra: Australian Bureau of Statistics, 2015.

[18] ABS, *Australian Industry. Catalogue Number 8155.0*. Canberra: Australian Bureau of Statistics, 2015.

[19] M. Bailey, "Australia named amongst best five countries to be an entrepreneur.," *BRW, Fairfax Media Publ.*, 2013.

[20] GEDI, *The Global Entrepreneurship and Development Index*. The Global Entrepreneurship and Development Institute, 2015.

[21] Treasury, *2015 Intergenerational Report. Australia in 2055*. Canberra: The Treasury, Australian Government, 2015.

[22] AIHW, *Australia's welfare no. 12. Catalogue Number AUS 189*. Australian Institute of Health and Welfare, 2015.

[23] ABS, *Labour Force, Australia. Catalogue Number 6202.0* . Canberra: Australian Bureau of Statistics, 2015.

[24] L. Robinson, C. Magee, M. Safadi, and R. Sharma, "Health Profile of Australian Employees," Centre for Health Initiatives, University of Wollongong, 2014.

[25] Obesity Australia, *Obesity: A National Epidemic and its Impact on Australia*. Obesity Australia Website (www.obesityaustralia.org), 2014.

[26] ABS, *Mental Helath and Wellbeing: Profile of Adults, Australia. Catalogue Number 4326.0*. Canberra: Australian Bureau of Statistics, 1997.

[27] ABS, *National Survey of Mental Health and Wellbeing: summary of results. Catalogue Number 4326.0*. Canberra: Australian Bureau of Statistics, 2007.

[28] AIHW, *Australia's health 2014. Australia's health series no. 14. Catalogue number AUS 178*. Canberra: Australian Institute of Health and Welfare, 2014.

[29] ABS, *Migration, Australia, 2013-14. Catalogue Number 3412.0*. Canberra: Australian Bureau of Statistics, 2014.

[30] OECD, *"What Are the Earnings Advantages from Education?" Education Indicators in Focus, No. 27*. Paris: OECD Publishing, 2014.

[31] Department of Employment, *Employment Outlook to November 2019*. Department of Employment, 2015.

[32] ABS, *Labour Force, Australia, Detailed. October 2015. Catalogue Number 6291.0.55.001*. Canberra: Australian Bureau of Statistics, 2015.

[33] PwC, "A smart move: Future-proofing Australia's workforce by growing skills in science, technology, engineering and maths (STEM)," PricewaterhouseCoopers, Sydney, 2015.

[34] J. Kennedy, T. Lyons, and F. Quinn, "The continuing decline of science and mathematics enrolments in Australian high schools," *Teach. Sci.*, vol. 60, no. 2, pp. 34–46, 2014.

[35] DET, *UCube. Completion Count by Year by Field Of Education by Citizenship Category* . Department of Education and Training, 2015.

[36] OECD, "Education at a Glance," OECD, 2014.

[37] OECD, *"How is the global talent pool changing (2013, 2030)?" Education Indicators in Focus, No. 31*. Paris: OECD Publishing, 2015.

[38] WIPO, *Statistical Country Profiles: Australia*. Geneva: World Intellectual Property Organization, 2015.

[39] M. Paz-Marin, P. A. Gutierrez, and C. Hervas-Martinez, "Classification of countries' progress toward a knowledge economy based on machine learning classification techniques," *Expert Syst. Appl.*, vol. 42, p. 562–572, 2015.

[40] CEDA, *Australia's future workforce?* Melbourne: Committee for Economic Development of Australia, 2015.

[41] CCI, *Australian Creative Economy Report Card 2013*. ARC Centre of Excellence for Creative Industries and Innovation (www.cci.edu.au), 2013.

[42] PWC, "The Economic Contribution of Australia's Copyright Industries 2002 - 2014. Prepared for the Australian Copyright Council (2015)," 2015.

[43] Deep Focus and Cassandra, *Cassandra Report: Gen Z*. Cassandra Website (https://cassandra.co/), 2015.

[44] R. Wartzman, "Coming soon to your office: Gen Z," *Time*, vol. Feb., 12 2, 2014.

[45] WIKIA, "Generation Z: A look at the technology and media habits of today's teens," 2013. .

[46] D. Schawbel, "Gen Y and Gen Z Global Workplace Expectations Study," *Millenial Branding*. Millennial Branding and Randstad US, 2014.

[47] Robert Half and Enactus, "Get Ready for Generation Z," 2015.

[48] J. Fry and C. Boulton, *Prevalence of transition pathways in Australia*. Canberra, AU: Productivity Commission, 2013.

[49] WHO, *Global strategy on occupational health for all: The way to health at work. Second Meeting of the WHO Collaborating Centres in Occupational Health in Beijing, China 11-14 October*. Geneva: World Health Organisation, 1994.

[50] UKCES, *The future of work: Jobs and skills in 2030*. London: United Kingdom Government Commission for Empoyment and Skills, 2014.

[51] ILO, *The Future of Work Centenary Initiative*. Geneva: International Labour Office, 2015.

[52] E. Brynjolfsson and A. McAfee, *The second machine age: Work, progress, and prosperity in a time of brilliant technologies*. WW Norton & Company, 2014.

[53] CSF, *Foresight*. Singapore: Centre for Strategic Futures, Prime Minister's Office, Singapore, 2015.

[54] AlphaBeta Strategy and Economics, *The new work order: Ensuring young Australians have skills and experience for the jobs of the future, not the past*. Sydney: AlphaBeta Strategy and Economics, Foundation for Young Australians, 2015.

[55] C. Feinstein, "Pessimism Perpetuated: Real Wages and the Standard of Living in Britain during and after the Industrial Revolution," *J. Econ. Hist.*, vol. 58, no. 3, pp. 625–658, 1998.

[56] S. Fothergill and T. Gore, *The implications for employment of the shift to high-value manufacturing*. London: United Kingdom Government Office for Science, Foresight, 2013.

[57] R. Kurzweil, *The singularity is near: When humans transcend biology*. Penguin, 2005.

[58] ITU, *Information and communications technology (ICT) facts and figures*. Geneva: International Telecommunication Union, 2015.

[59] Google, *Google Finance: Stock market quotes, news, currency ...* Mountain View, California: Google Finance (www.google.com/finance), 2015.

[60] T. Cowen, *Average is Over - Powering America beyond the age of the great stagnation*. New York: The Penguin Group, 2013.

[61] M. Barrie, *Freelancer limited - Third Quarter Update*. Australia: Freelancer, 2015.

[62] ABS, *Australian Labour Market Statistics. Catalogue Number 6105.0*. Canberra: Australian Bureau of Statistics, 2014.

[63] S. Szreter and G. Mooney, "Urbanization, mortality, and thestandard of living debate: newestimates of the expectation of lifeat birth in nineteenth-centuryBritish cities," *Econ. Hist. Rev.*, vol. L1, no. 1, pp. 84–112, 1998.

[64] OECD, *OECD Economic Surveys: Australia, November 2010. Overview*. Paris: OECD Publishing, 2010.

[65] Department of Industry, *Australian Industry Report 2014*. Canberra: Australian Government, Office of the Chief Economist, 2014.

[66] ABS, *Labour Force, Australia, Detailed. August 2015. Catalogue Number 6291.0.55.003*. Canberra: Australian Bureau of Statistics, 2015.

[67] ABS, *Measures of Australia's Progress: Summary Indicators, 2012. Catalogue Number 1370.0.55.001*. Canberra: Australian Bureau of Statistics, 2012.

[68] OECD, " Harmonised unemployment rate (HUR) (indicator)." 2015.

[69] A. Ballantyne, D. De Voss, and D. Jacobs, "Unemployment and spare capacity in the labour market," *Reserv. Bank Aust. Bull.*, vol. September, 2014.

[70] OECD and OECD, "How does Australia compare? OECD Employment outlook 2014," 2014.

[71] J. Fildes, A. Robbins, L. Cave, B. Perrens, and A. Wearring, *Mission Australia's 2014 Youth Survey Report*. Mission Australia, 2014.

[72] H. Morsy, "Scarred Generation.," *Financ. Dev. Int. Monet. Fund*, vol. 49, no. 1, 2012.

[73] L. B. Kahn, "The long-term labor market consequences of graduating from college in a bad economy," *Labour Econ.*, vol. 17, no. 2, pp. 303–316, 2010.

[74] S. Burgess, C. Propper, H. Rees, and A. Shearer, "The class of 1981: the effects of early career unemployment on subsequent unemployment experiences," *Labour Econ.*, vol. 10, no. 3, pp. 291–309, 2003.

[75] H. Peterson, "McDonald's shoots down fears it is planning to replace cashiers with kiosks," *Business Insider Australia*, 2015.

[76] ABS, *Average Weekly Earnings, Australia, May 2015. Catalogue Number 6302.0*. Canberra: Australian Bureau of Statistics, 2015.

[77] OECD, "OECD. Stat: Average annual wages." 2015.

[78] D. Acemoglu and D. Autor, "Chapter 12 - Skills, Tasks and Technologies: Implications for Employment and Earnings," in *Handbook of labor economics*, vol. Volume 4,, C. David and A. Orley, Eds. Elsevier, 2011.

[79] M. Goos, A. Manning, and A. Salomons, "Explaining Job Polarization: Routine-Biased Technological Change and Offshoring," *Am. Econ. Rev.*, vol. 104, no. 8, pp. 2509–2526, 2014.

[80] J. Jung and J. Mercenier, "Routinization-biased technical change and globalization: Understanding labor market polarization," *Econ. Inq.*, vol. 52, no. 4, pp. 1446–1465, 2014.

[81] G. L. Violante, "Skill-biased technical change," in *The New Palgrave Dictionary of Economics. Second Edition.*, S. N. Durlauf and L. E. Blume, Eds. Palgrave Macmillan, 2008.

[82] M. Sanders and B. ter Weel, "Skill-Biased Technical Change: Theoretical Concepts, Empirical Problems and a Survey of the Evidence," *DRUID (DANISH Res. UNIT Ind. Dyn.*, vol. Working pa, 2000.

[83] M. Coelli and J. Borland, "Job polarisation and earnings inequality in Australia. Working paper," 2015.

[84] P. Dawkins, P. Gregg, and R. Scutella, "Employment Polarisation in Australia," *Econ. Rec.*, vol. 81, no. 255, pp. 336–350, 2005.

[85] OECD, "OECD Family Database. The labour market position of families." 2013.

[86] ABS, *Education and Work, Australia, May 2014. Catalogue Number 6227.0*. Canberra: Australian Bureau of Statistics, 2014.

[87] S. A. Hajkowicz, H. Cook, and A. Littleboy, "Our Future World: Global megatrends that will change the way we live. The 2012 Revision.," CSIRO, Australia, 2012.

[88] CSIRO and Bureau of Meteorology, *Climate Change in Australia Information for Australia's Natural Resource Management Regions: Technical Report*. CSIRO, 2015.

[89] IPCC, *Summary for policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press, 2014.

[90] R. Niemelä, M. Hannula, S. Rautio, K. Reijula, and J. Railio, "The effect of air temperature on labour productivity in call centres—a case study," *Energy Build.*, vol. 34, no. 8, pp. 759–764, 2002.

[91] G. Heal and J. Park, *Goldilocks Economies? Temperature Stress and the Direct Impacts of Climate Change. NBER Working paper series*. National Bureau of Economic Research, 2015.

[92] R. S. Kovats and S. Hajat, "Heat Stress and Public Health: A Critical Review," *Annu. Rev. Public Health*, vol. 29, no. 1, pp. 41–55, 2008.

[93] S. C. Sherwood and M. Huber, "An adaptability limit to climate change due to heat stress," *Proc. Natl. Acad. Sci.*, vol. 107, no. 21, pp. 9552–9555, 2010.

[94] B. Dick, *Convergent Interviewing*. Brisbane: Interchange, 1990.

[95] W. Williams and D. Lewis, "Convergent interviewing: a tool for strategic investigation," *Strateg. Chang.*, vol. 14, pp. 219–229, 2005.

[96] G. Moore, "Cramming more components onto integrated circuits," *Electronics*, vol. 38, pp. 114–117, 1965.

[97] D. C. Brock and G. E. Moore, *Understanding Moore's law: four decades of innovation*. Philadelphia, PA: Chemical Heritage Foundation, 2006.

[98] Intel, *Intel Chips Timeline*. Intel Website (www.intel.com), 2012.

[99] W. D. Nordhaus, "Two centuries of productivity growth in computing," *J. Econ. Hist.*, vol. 67, no. 01, pp. 128–159, 2007.

[100] R. van der Meulen, "Gartner Says 6.4 Billion Connected 'Things' Will Be in Use in 2016, Up 30 Percent From 2015," *Gartner. Newsroom*, vol. 10 Novembe, 2015.

[101] S. Taylor, "10 Predictions for the Future of the Internet of Things," *CISCO Blogs*, vol. 3 June, 2015.

[102] L. Atzori, A. Iera, and G. Morabito, "The internet of things: A survey," *Comput. networks*, vol. 54, no. 15, pp. 2787–2805, 2010.

[103] W. Bock, D. Field, P. Zwillenberg, and K. Rogers, "The Growth of the Global Mobile Internet Economy – The Connected World," *Bost. Consult. Gr. Perspect.*, no. 10 February 2015, 2015.

[104] Google, *IPv6*. Google (www.google.com), 2011.

[105] L. A. Carroll, "Infographic: IPv4 vs IPv6," *Netw. Work Inc*, no. 7 October 2014, 2014.

[106] Sensis, "Sensis Social Media Report May 2015," *Sensis*, 2015.

[107] K. Kasper, "The 2014 Social Recruiting Survey Infographic," *Jobvite Website (www.jobvite.com)*, vol. 16 October, 2014.

[108] Australian Government, *Benefits of Social Media*. Business - Australian Government Website (www.business.gov.au), 2015.

[109] LinkedIn, *LinkedIn - About*. LinkedIn Corporation, 2015.

[110] B. Bajarin, "Why the Internet's Next Billion Users Will Be Mobile-Only," *Time Mag.*, 2014.

[111] WEF, *The Global Technology Report 2015*. World Economic Forum, 2015.

[112] ACMA, *Communications Report 2013-2014*. Australian Communications and Media Authority, 2014.

[113] ITU, *World Telecommunications/ICT Indicators Database*. International Telecommunication Union, 2014.

[114] EMC Corporation, *EMC/IDC Digital Universe Study*. EMC Website (www.emc.com), 2014.

[115] Microsoft, *The Big Bang: How the Big Data Explosion is Changing the World*. Microsoft Website (www.microsoft.com), 2013.

[116] IBM, *Stepping up to the challenge – CMO Insights from the Global C-suite Study*. IBM Institute for Business Value, 2014.

[117] G. Ostrovsky, "The BEAR: Battlefield Extraction-Assist Robot TM," *Vecna Technol.*, 2007.

[118] CISCO, *Cisco Customer Experience Report for Automotive Industry*. CISCO Website (www.cisco.com), 2013.

[119] BBC ASIA, "Five Things About Japan's Robot Hotel," *BBC News*, no. 17 July 2015, 2015.

[120] J. W. Kendrick, *Productivity trends in the United State, Issue 71*. Princeton University Press, 1961.

[121] R. E. Gallman and T. J. Weiss, "The service industries in the nineteenth century," in *Production and productivity in the service industries*, NBER, 1969, pp. 287–381.

[122] L. D. Johnston, *History lessons: Understanding the decline in manufacturing*. MinnPost Website (www.minnpost.com), 2012.

[123] Oxford English Dictionary, "Globalization," *Oxford English Dict. Online*, 2009.

[124] N. R. F. Al-Rodhan and G. Stoudmann, *Definitions of globalization: A comprehensive overview and a proposed definition*, vol. 6. Geneva: Geneva Centre for Security Policy, 2006.

[125] Elon University, *Imagining the Internet: History of Information Technologies*. Elon University School of Communications Website (www.elon.edu), 2014.

[126] ABS, *International Movements. Catalogue Number 3401.0*. Canberra: Australian Bureau of Statistics, 2014.

[127] J. McKendrick, "Cloud Computing Set to Skyrocket, Driven by Economy: Survey," *Forbes*, vol. 4 October, 2011.

[128] Deloitte, "How Cloud Computing is Changing IT Organizations," *Wall Str. J.*, vol. April 29,, 2013.

[129] C. Anderson and J. F. Gantz, *Climate Change: Cloud's Impact on IT Organizations and Staffing. White Paper.* Microsoft (news.microsoft.com): IDC Information and Data, 2012.

[130] L. Powell, "Shedding a tier: flattening organisational structures and employee empowerment," *Int. J. Educ. Manag.*, vol. 16, no. 1, pp. 54–59, 2002.

[131] R. G. Rajan and J. Wulf, "The flattening firm: Evidence from panel data on the changing nature of corporate hierarchies," *Rev. Econ. Stat.*, vol. 88, no. 4, pp. 759–773, 2006.

[132] M. Guadalupe, H. Li, and J. Wulf, *Who lives in the c-suite? Organizational structure and the division of labor in top management*. National Bureau of Economic Research, 2012.

[133] G. L. Neilson and J. Wulf, "How many direct reports?," *Harv. Bus. Rev.*, vol. April 2012, 2012.

[134] L. Dubois, *DARPA's Approach to Innovation and Its Reflection in Industry, in Reducing the Time from Basic Research to Innovation in the Chemical Sciences: A Workshop Report to the Chemical Sciences Roundtable*. Washington DC: National Research Council (US) Chemical Sciences Roundtable, 2003.

[135] MBO Partners, *MBO Partners State of Independence in America 2015. Five Years of Insight on the Growth of the Independent Workforce.* MBO Partners Website (www.mbopartners.com), 2015.

[136] L. Gardiner, "Does the gig economy revolutionise the world of work, or is it a storm in a teacup?," *Econ.*, vol. Oct 23 201, 2015.

[137] ABS, *Forms of employment. Catalogue Number 6359.0*. Canberra: Australian Bureau of Statistics, 2009.

[138] ABS, *Characteristics of Employment, Australia, August 2014. Catalogue Number 6333.0*. Canberra: Australian Bureau of Statistics, 2014.

[139] C. Foertsch, *The Coworker's Profile*. Deskmag Website (www.deskmag.com), 2011.

[140] K. Butler, "Works Well With Others," *Mother Jones*, 2008.

[141] M. Pasquier, "The Future of Coworking: Coworking visas, corporate partnerships and real-estate specialists.," *Innov. is Everywhere*, 2015.

[142] A. Konrad, "Inside The Phenomenal Rise Of WeWork," *Forbes*, vol. 5 November, 2014.

[143] L. et al Gellman, "WeWork: Now a $5 Billion Co-Working Startup," *Wall Str. J.*, vol. 15 December, 2014.

[144] J. Wilkinson, "Threat of New Entrants (one of Porter's Five Forces).," *Strateg. CFO*, 2013.

[145] AFP, "'Sharing economy' reshapes markets, as complaints rise.," *Dly. Mail Aust.*, no. 4 February 2015, 2015.

[146] M. Brandt, "Uber Becomes the World's Most Valuable Startup," *Stat.*, no. 4 August 2015, 2015.

[147] USCB, *Longitudinal Business Database 1977-2012*. 2015.

[148] S. Shane, "Small Business Employment Share Shrinking for a Good Reason," *Small Bus. Trends*, 2013.

[149] PWC, *Small Business: Digital Growth*. Sydney: PricewaterhouseCoopers, 2015.

[150] S. Blank, "Why the lean start-up changes everything," *Harv. Bus. Rev.*, vol. 91, no. 5, pp. 63–72, 2013.

[151] S. Blank, "Lean Innovation Management – Making Corporate Innovation Work," *Forbes*, no. 25 June 2015, 2015.

[152] T. Agan, "The Secret to Lean Innovation is Making Learning a Priority," *Harvard Bus. Rev.*, no. 23 January 2014, 2014.

[153] ABS, *Venture Capital and Later Stage Private Equity, Australia. Catalogue Number 5678.0*. Canberra: Australian Bureau of Statistics, 2015.

[154] Asia-Pacific Banking and Finance, "Venture Capital not working in Australia," *Aust. Bank. Financ. Website*, 2015.

[155] BRA, "An Overview of Australia's Venture Capital Industry," *Bus. Rev. Aust.*, 2011.

[156] Snowball Group, *Evolution of Venture Capital in Australia. White Paper*. Snowball Group Website (www.snowballgroup.com.au), 2014.

[157] C. Fitzsimmons, "How venture capital sucks our best growth companies to the US," *BRW. Fairfax Media Publ.*, no. 31 August 2015, 2015.

[158] PWC, *Moneytree Report*. Washington: PricewaterhouseCoopers & National Venture Capital Association, 2015.

[159] NVCA, "Venture Impact: The Economic Importance of Venture Backed Companies to the US Economy," *Washingt. DC Glob. Insights NVCA*, 2011.

[160] NVCA, "Venture impact: The economic importance of venture capital backed companies to the US economy," *Washingt. DC Glob. Insights NVCA*, 2007.

[161] J. Nicholas, "Charts: Venture capital is becoming increasingly important to the US economy," *Money Mark. Bus. Insid. Aust.*, vol. 26 October, 2015.

[162] I. A. et al Strebulaev, "How Much Does Venture Capital Drive the U.S. Economy?," *Stanford Grad. Sch. Bus.*, 2015.

[163] M. Muir, "Three Trends in 2014 Venture Capital Funding," *Ventur. Alley, DLA Piper*, 2015.

[164] C. Kent, *Cyclical and structural changes in the labour market. Address by Mr Christopher Kent, Assistant Governor (Economic) of the Reserve Bank of Australia, to the Wall Street Journal's Labour Market Developments gathering, Sydney, 16 June 2014*. Reserve Bank of Australia, 2014.

[165] ABS, *Population Projections, Australia, 2012 (base) to 2101. Catalogue Number 3222.0* . Canberra: Australian Bureau of Statistics, 2013.

[166] ABS, "Australian Historical Population Statistics. Catalogue Number 3105.0.65.001. ." Australian Bureau of Statistics, Canberra, 2014.

[167] Productivity Commission, "Caring for Older Australians. Report No. 53, Final Inquiry Report," Productivity Commission, Canberra, 2011.

[168] ABS, *The Census of Population and Housing. Catalogue Number 2001.0*. Canberra: Australian Bureau of Statistics, 2011.

[169] WGEA, *Gender pay gap statistics September 2015*. Canberra: Workplace Gender Equality Agency, Australian Government.

[170] Australian Super, *Women and super*. Australian Super Website (www.australiansuper.com), 2015.

[171] DET, *Higher Education Students Time Series Tables. Selected Higher Education Statistics 2000*. Department of Education and Training, 2001.

[172] DET, *UCube. Enrolment count by gender, year* . Department of Education and Training, 2015.

[173] OECD, "Ageing and Employment Policies - Statistics on average effective age of retirement." 2012.

[174] Rice Warner, "Retirement Savings Gap as at 30 June 2013 FSC," 2013.

[175] DIBP, *Historical Migration Statistics*. Department of Immigration and Border Protection, 2015.

[176] ABS, *Australian Health Survey 2011-12. Updated results. Catalogue Number 4364.0.55.003.* . Canberra: Australian Bureau of Statistics, 2012.

[177] K. S. J. G. Diana Hetzel, "The socioeconomic gradient and chronic illness and associated risk factors in Australia: how far have we travelled?" Public Health Information Development Unit (University of Adelaide), 30-Mar-2015.

[178] L. Brown and B. Nepal, "Health Lies in Wealth: Health Inequalities of Australians of Working Age," Sep. 2010.

[179] AIHW, "Prevalence of diabetes," *Aust. Inst. Heal. Welf.*, no. Viewed 01.10.2015, 2015.

[180] NBN, *Super Connected Jobs. Understanding Australia's future workforce*. NBN, 2015.

[181] A. Case and A. Deaton, "Rising morbidity and mortality in midlife among white non-Hispanic Americans in the 21st century," *Proc. Natl. Acad. Sci.*, 2015.

[182] M. Kivimäki, M. Jokela, S. T. Nyberg, A. Singh-Manoux, E. I. Fransson, L. Alfredsson, J. B. Bjorner, M. Borritz, H. Burr, A. Casini, E. Clays, D. De Bacquer, N. Dragano, R. Erbel, G. A. Geuskens, M. Hamer, W. E. Hooftman, I. L. Houtman, K.-H. Jöckel, F. Kittel, A. Knutsson, M. Koskenvuo, T. Lunau, I. E. H. Madsen, M. L. Nielsen, M. Nordin, T. Oksanen, J. H. Pejtersen, J. Pentti, R. Rugulies, P. Salo, M. J. Shipley, J. Siegrist, A. Steptoe, S. B. Suominen, T. Theorell, J. Vahtera, P. J. M. Westerholm, H. Westerlund, D. O'Reilly, M. Kumari, G. D. Batty, J. E. Ferrie, and M. Virtanen, "Long working hours and risk of coronary heart disease and stroke: a systematic review and meta-analysis of published and unpublished data for 603 838 individuals," *Lancet*, vol. 386, no. 10005, pp. 1739–1746.

[183] L. Casey and R. Pui-Tak Liang, "Stress and wellbeing in Australia survey 2014," Australian Psychological Society, 2014.

[184] WHO, "Promoting Mental Health: Concepts, emerging evodence, practice," World Health Organisation, 2005.

[185] T. Fryers, D. Melzer, R. Jenkins, and T. Brugha, "The distribution of the common mental disorders: Social inequalities in Europe," *Clin. Pract. Epidemiol. Ment. Heal.*, vol. 1, no. 14, 2005.

[186] P. A. Creed, M. A. Machin, and R. E. Hicks, "Improving mental health status and coping abilities for long-term unemployed youth using cognitive-behaviour therapy based training interventions," *J. Organ. Behav.*, vol. 20, no. 6, pp. 963–978, 1999.

[187] D. H. Autor, "Polanyi's Paradox and the Shape of Employment Growth," MIT, NBER and JPAL, 2014.

[188] D. Kemp and A. Norton, "Review of the demand driven system: final report," Department of Education, 2014.

[189] OECD, *Education GPS. PISA 2012: Full selection of indicators*. gpseducation.oecd.org: OECD, 2012.

[190] OECD, *PISA 2009 Results: Learning Trends: Changes in Student Performance Since 2000 (Volume V)*. Paris: OECD Publishing, 2010.

[191] H. Coates and D. Edwards, *The 2008 Graduate Pathways Survey: Graduate education and employment outcomes five years after completion of a bachelor degree at an Australian university*. Australian Council for Educational Research, 2009.

[192] J. J. Heckman and T. Kautz, "Hard evidence on soft skills," *Labour Econ.*, vol. 19, no. 4, pp. 451–464, 2012.

[193] Department of Education Victoria, *Employability Skills Framework*. Department of Education, Victoria, 2006.

[194] A. Norton, "Mapping Australian higher education 2014-15," Grattan Institute, Grattan Institute, 2014.

[195] National Commission of Audit, *Towards Responsible Government. Appendix to the Report of the National Commission of Audit – Volume 1* . Canberra: National Commission of Audit, Australian Government, 2013.

[196] UQ, "UQx hits half a million enrolments," 2015. .

[197] K. Jordan, *MOOC Completion Rates: The Data*, vol. 12 June 20. Katy Jordan Blog (www.katyjordan.com), 2015.

[198] G. Christensen, A. Steinmetz, B. Alcorn, A. Bennett, D. Woods, and E. J. Emanuel, "The MOOC Phenomenon: Who Takes Massive Open Online Courses and Why? Working paper.," *Soc. Sci. Res. Netw.*, no. 6 November 2013, 2014.

[199] A. D. Ho, J. Reich, S. Nesterko, D. T. Seaton, T. Mullaney, J. Waldo, and I. Chuang, "HarvardX and MITx: The first year of open online courses. HarvardX and MITx Working Paper No. 1," *Soc. Sci. Res. Netw.*, vol. 21 January, 2014.

[200] M. S. Bogdanowicz and E. K. Bailey, "The Value of Knowledge and the Values of the New Knowledge Worker: Generation X in the New Economy," *J. Eur. Ind. Train.*, vol. 26, no. 2–4, pp. 125–129, 2002.

[201] OECD, *"How pronounced is income inequality around the world and how can education help reduce it?" Education Indicators in Focus, No. 4*. Paris: OECD Publishing, 2012.

[202] D. A. Fleming and T. Measham, "Rich and poor: which areas of Australia are most unequal?," *Conversat.*, vol. September, 2015.

[203] D. Parham, *Labour 's Share of Growth in Income and Prosperity*, no. September. Productivity Commission. Visiting Researcher Paper, 2013.

[204] M. Lübker, *Labour Shares*. Geneva: Policy Integration Department, International Labour Office, 2007.

[205] OECD, "How does Australia compare ?," *OECD Employ. Outlook 2012*, 2012.

[206] GCA, *Graduate Destinations 2014*. Graduate Careers Australia, 2014.

[207] W. W. Powell and K. Snellman, "The Knowledge Economy," *Annu. Rev. Sociol.*, vol. 30, pp. 199–220, 2004.

[208] APEC, *Towards Knowledge-based Economies in APEC*. Singapore: APEC Economic Committee, 2000.

[209] ABS, *Australian National Accounts: National Income, Expenditure and Product. Catalogue Number 5206.0*. Canberra: Australian Bureau of Statistics, 2015.

[210] D. Trewin, *Discussion paper: Measuring a Knowledge-based Economy and Society. An Australian Framework. ABS Catalogue Number 1375.0*. Canberra: Australian Bureau of Statistics, 2002.

[211] B. J. and J. H. G. (1999). Pine, *The experience economy: Work is theatre & every business a stage*. Harvard Business Press, 1999.

[212] UNDP and UNCTAD, "Creative Economy Report 2010. Creative Economy: A Feasible Development Option," 2010.

[213] J. Sundbo and P. Darmer, *Creating Experiences in the Experience Economy. Services, Economy and Innovation*. Edward Elgar, 2008.

[214] UNESCO and UNDP, "Creative Economy Report 2013 Special Edition: Widening Local Development Pathways," UNDP, UNESCO, 2013.

[215] Millennial Branding and Internship.com, *The High School Careers Study*, no. 10.10.2015. Millennial Branding Website (millennialbranding.com), 2014.

[216] D. Schawbel, "51 Of The Most Interesting Facts About Generation Z," 2014.

[217] NSW Parliment, "Uber and Airbnb: the legal and policy debate in NSW," NSW Parliamentary Research Service, Sydney, 2015.

[218] S. Thomsen, "The NSW taxi industry's fight against UberX just went up another level," Business Insider Australia, Sydney, 2015.

[219] J. Strutt, "Taxi industry slams Uber in government submission, blames itself for not embracing technology," ABC News, Sydney, 2015.

[220] ATO, "Providing taxi travel services through ride-sourcing and your tax obligations," Australian Tax Office, Canberra, 2015.

[221] ODesk, *Annual Impact Report Elance ODesk*. California: Upwork Website (www.upwork.com), 2014.

[222] GIA, *Distance Learning Industry Market Report*. California: Global Industry Analysts, Inc., 2015.

[223] Freelancer, *Freelancer Job Search*. Sydney: Freelancer Technology Pty Ltd, 2015.

[224] BEA, *National Income and Product Accounts*. Washington: Bureau of Economic Analysis, 2015.

[225] J. Mokyr, C. Vickers, and N. L. Ziebarth, "The history of technological anxiety and the future of economic growth: Is this time different?," *J. Econ. Perspect.*, vol. 29, no. 3, pp. 31–50, 2015.

[226] D. H. Autor, D. Dorn, and G. H. Hanson, "The China Syndrome: Local labor market effects of import competition in the United States," *Am. Econ. Rev.*, vol. 103, no. 6, pp. 2121–2168, 2013.

[227] M. Goel, "Does offshoring lift all boats? the role of induced technology adoption and innovation. Working paper," 2012.

[228] G. I. P. Ottaviano, G. Peri, and G. C. Wright, "Immigration, Offshoring, and American Jobs," *Am. Econ. Rev.*, vol. 103, no. 5, pp. 1925–1959, 2013.

[229] D. H. Autor, F. Levy, and R. J. Murnane, "The skill content of recent technological change: An empirical exploration," *Q. J. Econ.*, vol. 116, no. 4, pp. 1279–1333, 2003.

[230] A. Akerman, I. Gaarder, and M. Mogstad, "The skill complementarity of broadband internet," *NBER Work. Pap.*, vol. 20826, 2015.

[231] E. Brynjolfsson and A. McAfee, *Race against the machine: How the digital revolution is accelerating innovation, driving productivity, and irreversibly transforming employment and the economy*. Digital Frontier Press, 2011.

[232] D. Lobo and M. Levin, "Inferring regulatory networks from experimental morphological phenotypes: A computational method reverse-engineers planarian regeneration," *PLoS Comput. Biol.*, vol. 11, no. 6, p. e1004295, 2015.

[233] D. Edmonds and T. Bradley, "A rising tide: automation within Australia's labour market," Department of Industry and Science, Canberra, 2015.

[234] D. H. Autor, "Why are there still so many jobs? The history and future of workplace automation," *J. Econ. Perspect.*, vol. 29, no. 3, pp. 3–30, 2015.

[235] T. H. Davenport and J. Kirby, "Beyond Automation," *Harv. Bus. Rev.*, vol. June 2015, 2015.

[236] D. H. Autor, D. Dorn, and G. H. Hanson, "Untangling trade and technology: Evidence from local labour markets," *Econ. J.*, vol. 125, no. 584, pp. 621–646, 2015.

[237] G. Michaels, A. Natraj, and J. Van Reenen, "Has ICT polarized skill demand? Evidence from eleven countries over twenty-five years," *Rev. Econ. Stat.*, vol. 96, no. 1, pp. 60–77, 2014.

[238] C. Goodhart, M. Pradhan, and P. Pardeshi, "Could demographics reverse three multi-decade trends?," *Morgain Stanley Res. Glob. Econ.*, vol. September, 2015.

[239] M. Goos, A. Manning, and A. Salomons, "Job polarization in Europe," *Am. Econ. Rev.*, vol. 99, no. 2, pp. 58–63, 2009.

[240] ABS, *Household Income and Wealth, Australia. Catalogue Number 6523.0*. Canberra: Australian Bureau of Statistics, 2015.

[241] E. Webster, *Occupational profiles of men since 1947*. Melbourne Institute of Applied Economic and Social Research, 1999.

[242] J. D. Sachs, S. G. Benzell, and G. LaGarda, "Robots: Curse or blessing? A basic framework," *Natl. Bur. Econ. Res. Work. Pap.*, vol. 21091, 2015.

[243] R. H. Coase, "The Nature of the Firm," *Economica*, vol. 4, no. 16, pp. 386–405, 1937.

[244] K. J. Arrow, *The limits of organization*. New York: W. W. Norton & co., 1974.

[245] Ø. D. Fjeldstad, C. C. Snow, R. E. Miles, and C. Lettl, "The architecture of collaboration," *Strateg. Manag. J.*, vol. 33, no. 6, pp. 734–750, 2012.

[246] O. E. Williamson, "The economics of organization: The transaction cost approach," *Am. J. Sociol.*, vol. 87, no. 3, pp. 548–577, 1981.

[247] O. E. Williamson, "Markets and hierarchies: Some elementary considerations," *Am. Econ. Rev.*, vol. 63, no. 2, pp. 316–325, 1973.

[248] CIE, *Survey of taxi drivers and operators: Preliminary survey results for the Sydney metropolitan transport district* . Sydney: Centre for Intrenational Economics, 2014.

[249] X. Gabaix and A. Landier, "Why has CEO pay increased so much?," *Q. J. Econ.*, vol. 123, no. 1, pp. 49–100, 2008.

[250] J. Waldfogel, "Digitization and the quality of new media products," in *Economic Analysis of the Digital Economy*, A. Goldfarb, S. M. Greenstein, and C. E. Tucker, Eds. National Bureau of Economic Research, 2015, p. 407.

[251] S. Peltier and F. Moreau, "Internet and the 'Long Tail versus superstar effect' debate: evidence from the French book market," *Appl. Econ. Lett.*, vol. 19, no. 8, pp. 711–715, 2012.

[252] M. Bourreau, M. Gensollen, F. Moreau, and P. Waelbroeck, "'Selling less of more?' The impact of digitization on record companies," *J. Cult. Econ.*, vol. 37, no. 3, pp. 327–346, 2013.

[253] A. Thierer, C. Koopman, A. Hobson, and C. Kuiper, "How the internet, the sharing economy, and reputational feedback mechanisms solve the 'lemons problem,'" *Mercat. Work. Pap.*, 2015.

[254] A. Tabarrok and T. Cowen, "The end of asymmetric information," *Cato Unbound*, 2015.

[255] P. Phillips, K. Zigan, M. M. Santos Silva, and R. Schegg, "The interactive effects of online reviews on the determinants of Swiss hotel performance: A neural network analysis," *Tour. Manag.*, vol. 50, no. 0, pp. 130–141, 2015.

[256] M. Luca, "Reviews, reputation, and revenue: The case of Yelp. com," *Harvard Bus. Sch. NOM Unit Work. Pap.*, no. 12–016, 2011.

[257] S. Berry and J. Waldfogel, "Product quality and market size," *J. Ind. Econ.*, vol. 58, no. 1, pp. 1–31, 2010.

[258] IBM, *Bringing big data to the enterprise - What is big data?* IBM Website (https://www.ibm.com), 2015.

[259] M. Janssen, Y. Charalabidis, and A. Zuiderwijk, "Benefits, Adoption Barriers and Myths of Open Data and Open Government," *Inf. Syst. Manag.*, vol. 29, no. 4, pp. 258–268, 2012.

[260] L. Columbus, "Where Big Data Jobs Are In 2015 - Midyear Update," vol. 25 June 20, 2015.

[261] IBM, *What is a data scientist?* IBM Website (https://www.ibm.com), 2015.

[262] PWC and EIU, *Gut & Gigabytes - Capitalising on the art & science in decision making*. London: Published by Price Waterhouse Coopers and Written by The Economist Intelligence Unit, 201AD.

[263] B. Schwartz, "The Paradox of Choice," in *Positive Psychology in Practice: Promoting Human Flourishing in Work, Health and Education and Everyday Life*, S. Joseph, Ed. New York: John Wiley and Sons Inc, 2015, pp. 121–138.

[264] ACUO, *Training*. Australian Certified Unmanned Aerial Vehicle Operators (http://www.acuo.org.au/industry-information/training/), 2015.

[265] A. Woodard, *Australia grapples with its growing fleet of drones*. Sydney: BBC News, 1 February, 2015.

[266] CASA, *What are remotely piloted aircraft (RPA)? History*. Canberra: Civil Aviation Safety Authority Website (www.casa.gov.au), 2015.

[267] P. Hagen, "The rise of the chief customer officer," *Harv. Bus. Rev.*, vol. April 2011, 2011.

[268] K. Jones, *So you want to be a personal trainer?* Sydney: Sydney Morning Herald, 22 October, 2013.

[269] BLS, *Occupational Outlook Handbook, 2014-15 Edition, Fitness Trainers and Instructors*. Washington DC: Bureau of Labor Statistics, U.S. Department of Labor, 2015.

[270] S. Colagiuri, C. M. Y. Lee, R. Colagiuri, D. Magliano, J. E. Shaw, P. Z. Zimmet, and I. D. Caterson, "The cost of overweight and obesity in Australia," *Med. J. Aust.*, vol. 192, no. 5, pp. 260–264, 2010.

[271] AIHW, *Mental health services - in brief. Catalogue Number HSE 154.* Canberra: Australian Institute of Health and Welfare, 2014.

[272] M. V Maciosek, A. B. Coffield, T. J. Flottemesch, N. M. Edwards, and L. I. Solberg, "Greater Use Of Preventive Services In U.S. Health Care Could Save Lives At Little Or No Cost," *Health Aff.*, vol. 29, no. 9, pp. 1656–1660, 2010.

[273] J. T. Cohen, P. J. Neumann, and M. C. Weinstein, "Does Preventive Care Save Money? Health Economics and the Presidential Candidates," *N. Engl. J. Med.*, vol. 358, no. 7, pp. 661–663, 2008.

[274] ACMA, *Click and connect: Young Australians use of online social media*. Canberra: Australian Communications and Media Authority, 2009.

[275] ABS, *Household Use of Information Technology, Australia, 2012-13. Catalogue Number 8146.0.* Canberra: Australian Bureau of Statistics, 2014.

[276] S. K. Dane, C. M. Mason, and B. A. O'Brien-McInally, "Household Internet use in Australia: A study in regional communities," vol. EP1310907. CSIRO, Brisbane, QLD, p. 54, 2013.

[277] L. Piercy, *Designing Digital Interventions - Reboot UK*. United Kingdom: Tinder Foundation, 2015.

[278] Infoxchange, *Infoxchange and Australia Post - Helping Australians realise their digital potential*. Australia (www.infoxchange.net.au): Infoxchange Australia, 2015.

[279] C. M. Mason, S. K. Dane, S. Meikle, C. Griffith, and A. Dormer, *Supporting digital inclusion for social housing communities: A joint statement by stakeholder organisations.*, no. EP145928. Brisbane, Australia: CSIRO, 2014.

[280] Infoxchange Australia and A.T.Kearney, "Assessing the economic benefits of digital inclusion," Infoxchange Australia, Melbourne, VIC, 2009.

[281] S. Yu, T. Bretherton, J. Schutz, and J. Buchanan, *Understanding the nature of vocations today: Exploring labour market pathways.* Adelaide: National Vocational Education and Training Research Program Working Paper, 2012.

[282] S. Weller, "Critical events and labour mobility: Relocations in the wake of the Ansett Airlines collapse," *Geogr. Res.*, vol. 47, pp. 242–255, 2009.

[283] C. Chapain and A. Murie, "The impact of factory closure on local communities and economies: The case of the MG Rover Longbridge closure in Birmingham," *Policy Stud.*, vol. 29, pp. 305–317, 2008.

[284] D. Galster, E. Rosenstein, and J.-M. Bonvin, "Assessing integrated employment policies against the capablity approach: A Swiss case study," *Int. J. Sociol. Soc. Policy*, vol. 29, pp. 637–648, 2009.

[285] S. Gascoigne and N. Whiteside, "The promotion of capabilities in Sweden: A case study of the contraction of shipbuilding in Gothernburg," *Int. J. Sociol. Soc. Policy*, vol. 29, pp. 587–598, 2009.

[286] A. E. Green and M. Orton, "The Integration of Activation Policy at Sub-national level: A case study of the City Strategy initiative in an English sub-region," *Int. J. Sociol. Soc. Policy*, vol. 29, pp. 612–623, 2009.

[287] R. Monteleone and C. Mozzana, "Integrated employment policies for disabled people: Organisational innovation between obstacles and opportunities," *Int. J. Sociol. Soc. Policy*, vol. 29, pp. 649–661, 2009.

[288] J. Haltiwanger and R. S. Jarmin, "Measuring the digital economy," in *Understanding the Digital Economy*, E. Brynjolfsson and B. Kahin, Eds. Cambridge, MA: MIT Press, 2002.

[289] OECD, *Measuring the Digital Economy: A new perspective*. Paris: OECD Publishing, 2014.

[290] C. Ess and E. Buchanan, "Internet research ethics: The field and its critical issues," in *Information and computer ethics*, K. Himma and H. Tavani, Eds. Hoboken, NJ: Wiley, 2008, pp. 273–292.

[291] W. Deresiewicz, *Excellent sheep: The miseducation of the American elite and the way to a meaningful life*. Free Press, 2014.

[292] G. Thorsteinsson, "Innovation Education to Improve Social Responsibility through General Education," *Tiltai*, vol. 61, no. 4, pp. 71–78, 2014.

[293] Digital Education Advisory Group, "Beyond the Classroom: A new digital education for young Australians in the 21st century," Department of Education Employment and Workplace Relations, Canberra, 2013.

[294] J. He, J. Bailey, B. I. P. Rubinstein, and R. Zhang, *Identifying At-Risk Students in Massive Open Online Courses*. University of Melbourne (www.unimelb.edu.au), 2015.

[295] M. Ally, *Mobile learning: Transforming the delivery of education and training*. Edmonton, CA: AU Press, 2009.

[296] D. McNeill, *Western Sydney innovation corridor: Discussion paper*. Sydney, AU: University of Western Sydney, 2015.

[297] M. R. Miller, "Getting paid in the naked economy," *Hofstra Labor Employ. Law J.*, vol. 33, pp. 279–299, 2015.

[298] D. Ucbasaran, D. A. Shepherd, A. Lockett, and S. J. Lyon, "Life after business failure: The process and consequences of business failure for entrepreneurs," *J. Manage.*, vol. 39, pp. 163–202, 2013.

[299] European Commission, *A second chance for entrepreneurs: Prevention of bankruptcy, simplication of bankruptcy procedures and support for a fresh start*. Burssels, BE: European Commission, 2011.

[300] M. Knott, "nnovation statement: what you need to know about Malcolm Turnbull's plan," *Sydney Morning Her.*, vol. 7 December, 2015.

[301] PM, *National Innovation and Science Agenda*. Canberra: Prime Minister of Australia Website (www.pm,gov,au), 2015.

[302] T. Johns and L. Grattan, "The third wave of virtual work.," *Harvard Bus. Rev.*, vol. Jan-Feb 20, pp. 1–9, 2013.

[303] ACSC, *Australian Cyber Security Centre 2015 Threat Report*. Australian Cyber Security Centre, 2015.

[304] Australian Government, "Online Safety," Australian Government Website (www.australia.gov.au), 2015.

[305] J. Rifkin, *The zero marginal cost society*. Basingstoke, UK: Palgrave Macmillan, 2014.

[306] D. M. West, "What happens if robots take the jobs? The impact of emerging technologies on employment and public policy." Centre for Technology Innovation at Brookings, Washington DC, 2015.

[307] J. Naisbitt, *Megatrends - Ten New Directions Transforming Our Lives*. New York: Warner Books, 1982.

PHOTOS

Pages 6, 34, 70, 83, 90 © CSIRO; pages 11, 16, 47 © Department of Employment; pages 20, 21, 39, 42, 61, 66, 79, 83, 93 © istock; page 30 Peter Miller, flickr CC; page 56 Tom Mesic, flickr, CC BY-NC-ND 2.0.

CONTACT US

t 1300 363 400
+61 3 9545 2176
e csiroenquiries@csiro.au
w www.csiro.au

AT CSIRO, WE DO THE EXTRAORDINARY EVERY DAY

We innovate for tomorrow and help improve today – for our customers, all Australians and the world.

WE IMAGINE. WE COLLABORATE. WE INNOVATE.

FOR FURTHER INFORMATION

Dr Stefan Hajkowicz
Senior Principal Scientist
Strategy & Foresight Team
Data61 | CSIRO
t +61 7 3833 5540
e stefan.hajkowicz@csiro.au
w www.data61.csiro.au

Rose Verspaandonk
Branch Manager
Economics Branch
Australian Government Department of Employment
t + 61 2 6240 9262
e FutureOfWork@employment.gov.au
w www.employment.gov.au

B&M | 16-0026