A perspective on the coming decade of digital disruption
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If we get things right digital technology could boost Australia’s economic growth rate by between 0.7% to 1.2% per annum.¹

That raises national income by tens of billions of dollars and creates hundreds of thousands of new jobs. It’s nothing short of an economic transformation with the potential to deliver huge benefits to Australians from all walks of life. The opportunity exists because digital technology improves the efficiency of industry and opens up new growth markets for Australian firms across the globe. Digital will change what’s possible. Digital is set to reshape the way we live, work and play.

However, the benefits of digital are not assured for Australia. The economic and societal landscape is shifting. Existing markets are being extinguished and new markets are being created. Business, government and community decision makers are facing unfamiliar risks and opportunities. Data breaches, cybercrime, new sources of offshore competition and privacy concerns are also part of the digital package. The next ten years are likely to see the pace of change continue creating complex strategy dilemmas for governments, companies and individuals.

This report explores plausible futures using methods of strategic foresight pioneered at CSIRO’s Data61. We explore the coming decade of digital disruption through the lens of six interlinked megatrends using a Venn diagram to emphasise their interconnectedness. A megatrend is a significant shift in environmental, economic and social conditions that will play out over the coming decades. The concept was introduced by US professor John Naisbitt in his best-selling book of the same title in the early 1980s. Today’s megatrends are widely used by large organisations, particularly in the technology sector, to describe trajectories of change taking us toward a new and different future.
Digital technology can be defined to encompass all electrical devices which make use of information represented in digital form – such as binary code - to perform useful functions. Data connectivity is what makes a device (e.g. light bulb) earn the status of “digital” (e.g. computer screen). Computers, robots, software, smartphones and sensory systems are all digital technologies. When connected they can be very powerful and give rise to new systems for human communication, governance models and business processes. We sometimes use the term “digital” as a noun to capture both the technologies and the new human systems they enable.

Often referred to as the fourth industrial revolution, or the information era, the current chapter of the human history is characterised by digital transformation. Digital technologies are changing the way we live, work and play. They are changing information flows and decision-making behaviours. Digital is associated with the birth and rapid ascendance of entirely new cultures, markets and societal norms. The exciting and daunting reality is that we are in the early phases of this transformation. If industrial revolutions happen over centuries we’re still in the first quarter of the information era. The most significant change lies ahead.

Within this context organisations and individuals are faced with challenging strategic choices. Companies have seen what happened within the taxi industry and are actively asking: Who’s our Uber? Another phrase commonly used within many organisations is: What’s our Kodak moment? In other words, what’s the nascent digital technology which could at some point redefine our core operations and purpose? Such questions may be considered existential risk and put in the “too hard basket”. However, we have all witnessed events when an organisation’s existential risk (or opportunity) associated with digital technology quickly became an operational day-to-day reality.

This means we need to look ahead. Whilst the future cannot ever be known the emerging research field of strategic foresight can help people understand what may potentially unfold. Strategic foresight can help us contemplate multiple plausible futures and make wiser choices. The expectation for this type of thinking is on the rise. For example, the concept of anticipatory governance is gaining traction in the world of public policy and corporate strategy. Citizens and shareholders have heightened expectations that decision makers will unveil the “black swans” (hard-to-foresee events) of digital technology and take proactive action.
Strategic foresight is a field of research concerned with the structured analysis of future events and “the four P’s of the future”; namely the probable, plausible, possible and preferable. In this report we apply the strategic foresight concept of megatrends to analyse and explore driving forces of change related to digital technologies. A megatrend is a pattern of change reshaping the future operational and strategic context of government, industry and community organisations.

Megatrends typically play out over decadal time frames and occur at the intersection of numerous geopolitical, economic, environmental, social, technological and legal trends. Trends have tighter spatial, temporal and typological definition than megatrends. Megatrends build gradually but eventually express with explosive force. The extent to which the risk is averted, or the opportunity harnessed, comes down to how well the megatrend was read and the accuracy of early and proactive strategic actions.

The term megatrends was coined by the US academic John Naisbitt who wrote a New York Times bestselling book with the same title published in the year 1984. Some researchers refer to megatrends as “drivers of change” or “metatrends” which are closely related concepts. Today technology and consulting firms such as Hewlett Packard, Siemens, Price Waterhouse Coopers (PWC), The World Economic Forum, the European Commission, KPMG, University of Sydney Business School, Ernst and Young and countless other firms and institutions use the concept of megatrends to explore and describe forthcoming change.

This report considers the next ten years of digital transformation within the context of the longer term, and larger, information era. We aim to give governments, businesses and communities insight into near term trends and drivers. The report opens with an overview of the digital megatrends. Each megatrend is then briefly described with reference to a set of interconnected underlying trends and drivers. We conclude the report with a description of our strategic foresight methods.

1 Intelligent machines

The costs of automation are declining and the capabilities of automated systems are improving. The coming decade will see significant advances in sensory systems, machine learning, predictive analytics and artificial intelligence generally. This will be associated with more widespread deployment of automated systems with impacts on the workforce. Society is likely to be confronted with adaptation and ethical dilemmas as we decide how automated systems make decisions.

2 Digital dividends

Digital technology is being unleashed into every industry and every sphere of human activity. This is changing what’s possible. This has the potential to generate substantial productivity and efficiency gains for industry. Digital technology allows us to sweat infrastructure assets harder. Digital improves the quality of citizen and customer services in the finance, health, transport, accommodation, retail, education, policing and administrative sectors. Digital is associated with new products, and new sources of economic value with reduced or negligible environmental footprint.
3 Data driven
The operations of practically every business in just about every industry are increasingly being driven by data. The bank, shop, hotel, hospital, insurer and library are all becoming data science operations. Every business is concerned with acquiring, screening, analysing, interpreting and using data to perform function better and make wiser choices. The field of data science and informatics is exploding with rapid growth in jobs and professional communities. The privacy and confidentiality aspects of data have heightened prominence. Organisations of the future will be much more heavily data driven.

4 Burning platforms
Online platforms provide a clearinghouse for buyers (providers) and sellers (consumers) of goods, services and information to make efficient exchanges. Companies such as Amazon, Freelancer, Uber and Facebook have been hugely successful and have disrupted existing marketplaces. The next decade is likely to see the continued expansion and diversification of online platforms into new areas. Blockchain and distributed ledger technology provide unprecedented potential for disintermediation as they allow two parties to exchange not only information but value (money, contracts, property rights…) without an intermediary. Many well established firms are standing on a burning platform for change.

5 Online burnout
There are downsides to the digital revolution. Information overload, online harassment, cybercrime, cyber terrorism, sedentary behaviours, information interrupts, online manipulation and privacy breaches all represent considerable challenges for humanity. Many of these problems are in their early stages and despite considerable effort and investment are continuing to cause increased damage. Many are looking for an unplug option which doesn’t really exist. Over the next ten years these challenges will be met via a wave of technology innovation which aims to ensure people enjoy the upsides of digital with improved safety, security and overall experience.

6 Reality bites
Although digital is transforming many aspects of our lives, there are some things which never change. Simple pleasures like face to face interaction or a simple cup of coffee aren’t going away. One need only look at the visitor numbers to brick-and-mortar venues like museums or stadiums to see that regardless of the popularity of streaming services like Netflix, people still want to get together to see cultural or sporting events in person. The next decade will bring much of our work and life into the cloud, but fundamentally we will remain grounded in being human and seeking out human experiences.
Recent times have seen breathtaking achievements in artificial intelligence and automated systems. Computers and robotics are now solving complex problems using self-generated strategies. The ability of computerised systems to solve problems without explicit rules, instructions or guidance from human beings is core to this transformation in technological capability. The coming decade will see significant advances in sensory systems, machine learning, predictive analytics and artificial intelligence generally. This will be associated with more widespread deployment of automated systems with impacts on the workforce. Artificial intelligence is set to improve safety and efficiency across all industry sectors. It has the capacity to transform human existence and deliver improved quality of life. However, there will be legal, ethical and social challenges as we adapt to an artificial intelligence enabled world.

That little droid and I have been through a lot together.

– LUKE SKYWALKER CONCERNING THE FICTIONAL ROBOT R2D2 IN THE FILM STAR WARS
Technological innovation isn’t a straight line. It’s not like a skyscraper with one floor of scientific achievement built vertically on top of another. Innovation is better represented as an inverted pyramid where one idea leads to several more which support yet more ideas. In his new book “How Google Works” Google Chairman Eric Schimdt argues humanity is entering an era of “combinatorial innovation” where the pace of change is accelerating.

Combinatorial innovation means breakthroughs in sensory systems, predictive analytics, image analysis, speech recognition, machine learning, neural networks and other scientific fields are combining to create a new and much higher platform for future technological advancement.

Artificial intelligence isn’t a single system nor single technological breakthrough. It’s what happens at the convergence of multiple technologies and multiple fields of scientific research. Today’s building blocks for tomorrow’s artificial intelligence are more powerful, and more diverse, than ever before in history. This creates a future world with vast potential for transformative artificial intelligence technologies.

Machines that learn. The Chinese boardgame “Go” is more complicated than chess and involves advanced strategy. Nobody taught Google Deepmind’s software AlphaGo Zero how to play the game. It completely taught itself Tabula Rasa (from scratch) using neural networks and self-play. AlphaGo defeated Grandmaster Lee Sedol in 2016 and an upgraded version defeated world champion Li Kejie in 2017. Google pitted an improved AI, AlphaGo Zero, against the original AlphaGo and AlphaGo Zero won 100 straight games. In 2018, Chinese media reported that a distinct new Chinese-made AI, Golaxy, had also defeated Li. These achievements are significant because of self learning; these AIs devised their own strategies without explicit human instruction. We are entering a world where machines can learn and solve complex problems without our help or guidance.

Artificial intelligence is making it’s own artificial intelligence. In 2017 researchers at Google developed AutoML; an artificial intelligence software tool that makes (codes) its own artificial intelligence. In the same year AutoML built NASNet; another piece of artificial intelligence used to recognise objects in images (e.g. people, cars and animals). Google researchers reported that NASNet, which was coded by AutoML (not a human), was 82.7% accurate in identifying objects. This represents a 1.2% improvement upon previously published systems coded by humans.

Better at recognising faces. In 2014 computers with 98.5% accuracy outperformed humans at facial recognition with 97.5% accuracy. Today, facial recognition is routinely used as an alternative to household door locks and for smartphone activation.

Getting better at recognising emotions. One next step from face recognition is the ability to ascertain a person’s emotional state from a photograph or image. A team of Microsoft researchers built an emotion recognition system which achieved 59.4% validation accuracy. Automated emotion recognition has applications in education, healthcare, customer service and many other areas.
Better at speech recognition. In 2016 Microsoft researchers achieved a 5.9% error rate on speech recognition; on par with human performance. This has since been improved to 5.1%\(^6\), making computers better transcriptionists than humans.

Getting better at personality judgements. In 2015 computerised algorithms developed by researchers at the University of Cambridge and Stanford University\(^1\) made more accurate judgements about an individual’s personality traits compared to human friends, family, spouses and work colleagues.

Getting better at predicting legal judgements. In 2017 an artificial intelligence program called “Case Cruncher Alpha” was pitted against 100 lawyers from London’s best firms. The task was to predict the outcomes of 775 real cases relating to insurance mis-selling by the UK Financial Ombudsman. Case Cruncher achieved an accuracy rate of 86.6% compared to human lawyers with 66.3%.

Worse at folding towels. Talented scientists and engineers at the UC Berkely robotics school designed the Berkeley Robot for the Elimination of Tedious Tasks (Brett). Brett’s job was to pick-up and fold a towel. After years of effort Brett’s best time was 20 minutes. More recent improvements involving deep learning algorithms have achieved best times of 1.5 minutes. However, Brett still gets stumped routinely when the laundry is messy\(^{11}\). Overall humans of all ages and skills outperform Brett at folding towels in a matter of seconds.

Moravec’s Paradox. Brett’s towel folding tribulations fall within the space of Moravec’s paradox; an observation in the field of artificial intelligence that we can design computer algorithms which solve complex problems like winning at world-class chess or flying an aircraft but are unable to do simple tasks (for humans) like tying up shoelaces or folding a crumpled towel. Simple tasks that involve irregularity, complexity, creativity, ethical judgements and emotional intelligence are often beyond the reach of robotics. However, despite Moravec’s paradox there is still much scope for artificial intelligence to automate previously human performed tasks over the coming decade. Furthermore, artificial intelligence has amazed us in recent history by solving complex problems that were hitherto considered impossible for a robot.

Workforce impacts. In 2013, two University of Oxford academics, Carl Benedikt Frey and Michael Osborne, published a study\(^8\) examining the impacts of automation on 702 unique occupation types in the US economy. They found 47% were at risk of being replaced by a robot or computer. They also found a strong negative relationship between automation risk and wages (i.e. lower pay for jobs with a higher chance of being automated). A more recent study\(^9\) by the OECD published in 2018 found that 14% of jobs have a “high risk” of automation and another 32% will be substantially changed; meaning that 46% of all jobs will be significantly impacted. Whilst there is much debate, and many other estimates (higher and lower), the weight of evidence suggests around half of all jobs will be significantly impacted by automation. This represents an enormous transition for today’s workforce.

Governments and companies are making big investments. Media reports indicate the European Commission recently announced a 70% boost in its artificial intelligence research budget of 1.5 billion Euros (AUD $2.3 billion) by 2020 in an attempt to catch up with Asia and the United States\(^14\). In 2016, public and private sector spending in Europe totalled between AUD$3.7 to AUD$5.0 billion, compared to AUD$15.5 billion in Asia and AUD$27.9 billion in the United States. A report by McKinsey\(^6\) estimates that global technology corporations such as Google and Baidu spent AUD$26 to AUD$40 billion on AI with 90% going into research and development and 10% into acquisitions. They also estimate global investment in artificial intelligence has increased three times over the past four years.

Adoption and business transformation is lagging. Despite an explosion in investment and technological capabilities few businesses are adopting or adapting to an artificial intelligence enabled world economy. A study by McKinsey\(^6\) of over 3,000 executives across 14 industry sectors and 10 countries found that only 20% were using some type of artificial intelligence technology as a core part of their business. However, there are expectations for adoption to accelerate in coming years.

Beyond Asimov. The three laws of robotics written in the 1940s by science fiction writer Isaac Asimov are receiving renewed attention. And it might be time for an update with a whole lot more detail. That’s because advanced artificial intelligence with capabilities for autonomous decisions – especially in areas such as law enforcement, defence, healthcare, education, transportation, labour markets and security – will create increasingly complex social, cultural and ethical dilemmas. We are at the beginnings of understanding plausible and preferable artificial intelligence futures. There is much uncertainty about how things may play out and society’s preferred outcomes. At a recent technology conference in Paris Microsoft Chief Executive Officer Satya Nadella said that artificial intelligence is the “defining technology of our times” and “the future we will invent is a choice we make”\(^1\). This is perhaps the most powerful and daunting aspect of the artificial intelligence transformation. We are in the driver’s seat. We can choose and build the future we want.
Productivity is the efficiency via which the economy converts inputs into outputs. It’s a well-established metric of long term wealth generation potential. Digital technology has enormous potential to boost productivity and unleash gains across all sectors of the Australian and global economy. Digital technology allows us to do more with less via the efficient utilisation of natural resources and built assets. For example, sensory systems will provide early detection of wear and tear in critical infrastructure allowing for cost effective maintenance. In healthcare, agriculture, education, tourism, construction, safety, banking, finance and practically every industry sector digital technologies will improve the efficiency and effectiveness of operations. The wealth and well-being of future generations will be built upon digital innovation.

We know that the nation that goes all-in on innovation today will own the global economy tomorrow.

— FORMER US PRESIDENT BARACK OBAMA DURING HIS 2014 STATE OF THE UNION ADDRESS
The G20 defines the digital economy as “economic activity that includes using digitised information and knowledge as the key factor of production”. This broad definition means that digital activity touches almost every aspect of modern business, be it in e-commerce from the home, analytics in business, or the programming of robots on the factory floor.

To better gauge the impact of the digital economy, the US Bureau of Economic Analysis (BEA) stripped down its definition to just three areas: Information technology and telecommunications infrastructure (hardware), digital media (such as software), and e-commerce. Even with this narrow definition, the BEA found that it contributed over $USD 1.2 trillion to the US economy in 2016, representing 6.5% of GDP. The report found that it had been growing at an average annual rate of 5.6% over the last 10 years, compared to just 1.5% for the US economy as a whole.

The key takeaway was that the digital economy punches well above its weight.

Based on existing trends, a growing share of GDP across all the most dynamic economies in the world will rely on digital technology over the next decade. As new technologies enter the market and populations age across the developed world—reducing the proportion of working age people—growth in digital is likely to accelerate.

Beating the productivity slump. Productivity in Australia is subject to peaks and troughs, but in recent years it has been declining. Economic analyses frequently point out that the best way to reverse this trend is through investment in innovation and research, and much of this innovation is in turn driven by digital technology. Current estimates indicate that already existing digital technology could annually contribute between AUD $140 billion and $250 billion in GDP to Australia’s economy by 2025, and that digital technology could be responsible for a GDP increase of between 0.7 and 1.2 percentage points. Digital will be a key element in resolving Australia’s productivity slump, but the degree to which innovation is emphasised by both government and industry will determine how successfully Australia takes advantage of these opportunities.

Innovation is a complex solution. When Queenslanders were surveyed on their attitudes toward innovation, most felt that it was a vague term that needed context, but that it would ultimately play a key role in the future—for better or for worse. A recent OECD report called for “anticipatory governance” that would adopt inclusive innovation measures to extend the benefits of innovation to underrepresented groups. The extent to which governments and industry make plans to harness and distribute the benefits of innovation will be a key factor in determining how digital technology affects Australia’s future.
Robots make money. A report commissioned by the European Commission found that between 2007 and 2014, the number of robotics-focused business incubators in the EU had grown by 360%.²⁵ It’s no surprise why—robots often deliver powerful returns on investment. Economists studying the impacts of robotics between 1993 and 2007 found that in the countries studied, robotics had increased GDP by around 0.37 percentage points²⁶.

And boost productivity in new areas. Countries that significantly invest in robotics boost their labour productivity, in terms of value added per worker, though there is a saturation effect: Productivity growth slowed down at a certain concentration of robots. However, as robots and AI begin to handle new jobs that are less routine than factory production, new areas for rapid growth can be observed²⁶. In the Asia Pacific alone, it is predicted purchases of robotics will go from $86.7 billion AUD in 2017 to $213 billion in 2021²⁷.

Combining technologies is the key to saving money. When several technological advancements occur, the combined new capabilities can unlock new potential developments and cost savings. As an example, consider the technological advancements necessary for the CSIRO’s “Hovermap” project. Essentially, the device is mounted on a drone then uses laser beams and sensors to create detailed images of the inside or outside of structures in minutes, and can map mines, dangerous areas or crime scenes, reducing the time and costs involved²⁸. Hovermap wouldn’t have been possible without relatively recent developments in drones, lidar imaging and data storage and transmission. The technology provides an unprecedented capability for rapid and accurate mapping of three-dimensional structures (including in GPS denied environments).

More efficient freight and logistics. One company has already received approval to test new “platooning” technologies in Australia²⁹. A lead truck serves as the key driver, and other trucks following at a specific distance behind are linked to the first truck with advanced sensors—so only the first truck needs a human driver, though early waves of the technology are likely to still have human drivers in all vehicles. There are still issues to be worked out in tests, but the technology already has the promise of savings on both labour and fuel costs and demonstrates how autonomous technologies can be “partially autonomous” in early stages.

Reducing costs of maintenance. The old saying may go, “If it ain’t broke, don’t fix it”, but in reality, proactive maintenance means “fixing” infrastructure well before it’s broken. The problem is that even the best engineers don’t always know the best time to fix an asset, or which part of an asset is under the most stress. Digital technology will help reduce maintenance costs through improved sensor technologies—Data61, for example, placed 2400 sensors on the Sydney Harbour Bridge to help monitor the health of the supporting structures and assist in maintenance predictions³⁰. This kind of “smart infrastructure” has the potential to unlock significant cost savings in the decade ahead.

Aiding healthcare by predictions. New data technologies are being put to work in solving problems associated with overcrowded hospital wards. By analysing data via new digital tools, administrators can predict exactly when demand will spike, so they can staff and equip the hospital accordingly. It had previously been assumed that the number of inpatients was unpredictable, but when Australian scientists applied their prediction tool to emergency room admissions, they found it had a 90% success rate³¹. They are now looking at expanding the tool to other phenomena that may be predictable, like seasonal flu outbreaks, with the potential for savings—in both costs and lives.

And through follow up. With healthcare costs set to increase in the coming years as the elderly proportion of the population grows³², it is important that new technologies help reduce costs while improving patient care. Advances in telecommunications technologies and broadband speeds will be critical in driving the telehealth sector, which involves more than just communication between doctors and patients—it also helps specialists to consult each other on difficult cases. Already, some telehealth services are covered under Medicare³³, and Coviu, a startup that spun out of Data61, expects that by the end of 2018, 20,000 Australians will have used this telehealth app³⁴.

Digital can transform farming. Investment in agricultural technology surged in 2016, though the amounts are fairly modest compared to sums spent on digital internationally, or in other sectors like finance³⁵. Skills shortages are likely to limit adoption of digital agriculture technologies³⁶, but there are numerous examples of technology with vast potential to save on costs. Robots can detect whether orchards are ready for picking, while sensors are detecting salinity levels in oyster farms, with significant potential for cost savings³⁷.

Improving disaster management. In the midst of an emergency, good data is crucial in planning an immediate response, and government bodies are always on the lookout for new technologies that can help—Queensland’s Disaster Management Guidelines, for example, emphasise the importance of innovation³⁸. A recently trialled piece of Australian technology, SPARK, simulates the spread of wildfires based on local conditions, taking into account weather patterns and the ability to evaluate fire risks for thousands of types of plants. This can be used in developing strategies for dealing with wildfires, as well as wildfire response³⁹. New technologies hold the potential to help predict and prepare responses to a range of disasters and reduce the costs they impose at the same time.
Data is more than information. Data is both a resource and a currency in the digital era. Everyday tasks like using Google Maps or turning on Netflix are now driven by data. Everyone needs data now, be they individuals, businesses or government. The bank, hospital, shopping centre and even fast food takeaway shop of the future will be data science operations. The need for data analysis and informatics will continue to dramatically expand as the digital revolution changes the ways people make decisions and the very ways in which people live their lives.

Data is the new oil. It’s valuable, but if unrefined, it cannot really be used.

— CLIVE HUMBY, BRITISH MATHEMATICIAN
In 2017, Australia’s fibre connections doubled, reaching nearly 3 million subscribers\(^5\). Between 2015 and 2017, Australia doubled its entire data consumption from 1.7 million terabytes in the last three months of 2015\(^6\) to 3.5 million terabytes in the same period in 2017\(^7\).

The increase in data consumption from streaming services like Netflix\(^8\) parallels this growth and is likely a key contributor, and this illustrates how one technological advancement can dramatically drive up Australia’s data needs.

If just one technological development can multiply data consumption by such a dramatic extent in such a short time, then it is probable that the many data-driven technologies entering the market will push data consumption even higher, putting pressure on data infrastructure to keep up with demand. Society itself will change as data provision becomes a key focus of both leisure and business, with knock-on effects impacting the kinds of jobs that are available, the ways companies generate profit and the methods by which products are marketed and distributed.

**Gee Whiz, 5G is almost here.** The Australian Communications and Media Authority anticipates that 5G mobile technologies will begin rolling out from 2020\(^9\), though Telstra has also indicated it may be as soon as 2019\(^10\). 5G will not just be an incremental upgrade to speeds, rather, the government defines it as “the underlying architecture that will enable the next wave of productivity and innovation across different sectors of the Australian economy”\(^11\). The NBN network has already faced significant challenges meeting the rapidly expanding demand\(^12\), and 5G will play a role in meeting demand in future.

**With high speed potential.** Estimates of the potential speeds of 5G range between 25-50 Mbps in high traffic scenarios, through to minimums of 100Mbps in typical situations, all the way up to one Gbps per second for stationary users near cell towers\(^13\). If the potential of these estimates is realised it will be a game-changer for industry over the coming decade and transform the ways in which companies operate, but 5G-compatible smartphones will need to be developed\(^14\)—this indicates the possibility of a near-future scenario in which 4G smartphones are quickly rendered relatively obsolete in comparison.

**But keep the divide in mind.** Australia’s vast territory poses challenges to digital coverage for people in remote areas. A Digital Inclusion report commissioned by Telstra in 2017 found that the digital inclusion gap between capital cities and the rest of the country had narrowed overall in recent years, but the reverse had occurred in Victoria, New South Wales and Tasmania.\(^15\) The report also found that indigenous Australians, the elderly and the disabled had lower rates of digital inclusion.\(^16\) This will be crucial to keep in mind, because even if 5G lives up to its promise, it will be expensive to ensure wide coverage.\(^17\) OECD research indicates that there is a strong connection between economic growth and broadband connectivity,\(^18\) so digital infrastructure development will be a key component of ensuring the economic future of regional and rural Australia.

**Physical data infrastructure is booming.** A “hyperscale” data centre is a facility with thousands of servers, often defined by the fact it produces billions of dollars in annual revenue\(^19\). With global data traffic rising from an annual 220 zettabytes in 2016 to an estimated 850 ZB in 2021, more hyperscale data centres will need to be built to accommodate the sheer amount of data being produced\(^20\). There were only 336 hyperscale data centres around the world at the end of 2016, and this is expected to grow to a total of 628 in 2021, when they will handle just over half of the world’s data traffic\(^21\).

**But still needs public investment.** Only the biggest data giants can afford to build their own hyperscale data centres and even though the amount of data shared on the “private cloud” is growing, public cloud data is growing faster. In 2016, 58% of the total cloud data was handled via public data centres, though the amount of data shared on the “private cloud” is growing faster. In 2016, 58% of the total cloud data was handled via public data centres, and that is projected to rise to 73% in 2021\(^22\).

**Jobs of the future.** IBM predicts that by 2020, the number of job openings for data scientists in the US will reach 2,720,000, from 364,000 in 2016\(^23\). Along with data specialists, data generalists will be required, with managers needing to be able to grasp and utilise analytics in decision-making, not to mention the probability that basic data entry jobs will face significant change or automation in the years ahead as demand for data increases and new technologies offer solutions.

**Are already in high demand.** At present, not nearly enough data specialists are being trained to meet vacancies requiring advanced skills\(^24\), with the very real possibility that skills shortages will slow down growth of the sector. Over half of the managers polled in recent global surveys indicated that data analytics roles were the hardest to fill\(^25\).
With fierce competition for talent. Already, multinationals seek to poach talent from across borders, and wages for specialists working in machine learning remain attractive, driven by aggressive recruiting of specialists with experience. Tech giants and auto companies are both locked in fierce competition to recruit cutting edge AI researchers to work on AV technology\(^53\). As AI and Internet of Things (IoT) advances are incorporated into more technologies, demand for people with the right skills is likely to grow.

Personal data is money. Data has taken on characteristics of both a resource and a currency—this can be seen in the willingness of companies to pay users to allow their data to be harvested and traded. There are apps that pay users to play and rate mobile games, while survey companies regularly pay interviewees small amounts to fill out online forms used for marketing purposes. These types of unskilled tasks are likely to remain low paid, but could proliferate depending on how information is harvested in future.

But who owns the data? Multinational data giants like Google, Amazon and Facebook currently dominate the monetization of personal data, but blockchain-based apps are experimenting with systems that allow users to package and take charge of their own data so ordinary members of the public can sell their own data to whom they see fit\(^54\).

Blockchain has influential backers. Whether or not blockchain will succeed in empowering consumers to control their data remains to be seen. Existing data giants will fight to retain a level of control over consumer data in order to survive. But blockchain has its own backers—internationally, senior government and industry figures have recognised the potential of blockchain for restructuring the entire digital economy and have signed on to measures to promote it\(^55\).

Data in cities. Information technology hardware giants Cisco and Huawei are among a number of companies locked in competition to create entire learning ecosystems to drive cities. Huawei describes smart cities as the “digital transformation of a city to address challenges in the physical world”, and indicates that a series of cameras, sensors and IOT objects would act as “nerves” gathering information, with an Intelligent Operations Centre acting as a “brain”\(^56\). Huawei is in the early stages of an agreement with a city in Germany to work develop certain smart city projects, but in Australia key Huawei projects have stalled on national security grounds\(^57\). Technological, social, political and privacy concerns will all need to be considered as smart technologies make their way into cities worldwide.

Data in the home. In recent years, on-demand streaming services like Netflix have witnessed much faster growth than free to air competitors\(^58\). Streaming services require heavy data consumption\(^44\), and Australia’s recent rise in data consumption has occurred at the same time as the widespread uptake of streamed television\(^59\). As industry increasingly uses data in its operations, consumers will do so as well, with IoT devices increasingly being incorporated into smart-home operations.

And data in the mind. Human beings are subject to a wide array of cognitive biases which affect decision making\(^60\). Data can be free of bias, however the ways in which data is collected and presented is still often affected, to varying extents\(^61\). Machines and datasets, too, can reflect human cognitive biases if programmers use the wrong information, or as it’s referred to in the industry—garbage in, garbage out. Improved data collection methods have the potential to reduce human error, saving lives and money, but the best results will require skills, discipline and open-mindedness to process and act on the right information.

Data quality and quantity both matter. The ability to collect data—while respecting privacy—will be crucial to the quality of the data. When one type of data is available while others are not, it can affect the results—illustrated by facial recognition systems which have higher error rates when the people scanned are not caucasian\(^62\). This kind of problem plays out in people’s own judgements too—the availability heuristic is the tendency to believe and act on information that is familiar and available, rather than information that is good or hard to get\(^63\). A world awash with data, both good and bad, is a world where the availability heuristic runs the risk of burying good data and confirmation bias allows people to select sources that fit their ideology.
Uber, Facebook, Airbnb — some of the world’s biggest companies base their very existence on the platforms they designed to share data, but in a rapidly changing digital world, new methods of sharing information can create new data giants, wipe out existing companies or cause firms to merge and adapt in a constant state of evolution, destruction and renewal. The era of platform economics has just gotten started. We are likely to see disintermediation and re-intermediation of existing models as new technologies such as blockchain and artificial intelligence are deployed within the context of platform based business models.

While competitors poured flames on our market share, what happened at Nokia? We fell behind, we missed big trends, and we lost time. At that time, we thought we were making the right decisions; but, with the benefit of hindsight, we now find ourselves years behind.

– STEPHEN ELOP, FORMER NOKIA CEO AND CURRENT EXECUTIVE STRATEGIST AT TELSTRA, WRITING IN HIS INDUSTRY-DEFINING BURNING PLATFORMS MEMO
In 2011, Nokia CEO Stephen Elop coined the phrase “burning platforms” in a memo when he recounted the tale of an oil rig worker forced to jump into icy waters as flames engulfed his oil platform—it was an analogy for Nokia’s loss of market share against Apple and Android, and Nokia’s failure to keep up with change.

When the term “platform” is used in the digital context, in the broadest sense it refers to software that allows users to interact with each other, generally via the uploading and sharing of data. Whether it’s Ebay, Facebook or a file-sharing torrent site, their existence depends on this data being shared. Platforms are increasingly central to the way modern firms operate, but in a world where the methods used to share data are always changing, companies can rise and fall faster than ever before. Elop’s flames are lapping at the edges of digital platforms, and the ways in which they respond will affect much more than just the digital and corporate ecosystems of the next decade.

Rising and falling. In 1964, companies on the S&P500 had an average tenure of 33 years, and by 2016 that had decreased to 24 years. By 2027, that average S&P tenure is expected to shrink to just 12 years. Around half of the companies on the S&P 500 face the risk of losing their spot in the next 10 years. New entrants to the S&P in the last decade included digital heavyweights like Facebook and Activision Blizzard, and those exiting also included companies that soared in on the digital revolution, such as Yahoo and Dell. Digital disruption has hit retail particularly hard, and Amazon and Walmart are now taking their fight to the digital space, with Walmart investing heavily in e-commerce.

Industries transform communities. Uber’s home city of San Francisco saw a 65 percent drop in the average number of rides per taxi between 2012 and 2014. Studies have indicated that the salaries of wage-earning taxi drivers have fallen, while self-employed drivers have dramatically increased in number. Even as the debate over flexibility vs. job stability and benefits continues, the industry has already transformed and enormous new tech-transport hybrid companies have emerged.

These transformations are sudden. Uber first arrived in Australia in 2012, offering just hire cars. In 2014, UberX launched ride-sharing. Since then, it has covered all the major population centres in the country. Some estimates place the economic benefit of Uber’s operations in Brisbane, Melbourne, Sydney and Perth at a combined value of $81 million per year to consumers and indicate that growth is still occurring in the taxi industry as well.

With more on the way. More industry transformations are on the way and these changes won’t “wait in line”. In the automotive industry alone, factors relating to electric vehicle uptake, autonomous vehicles and ride-sharing all affect plausible scenarios. A key facet of megatrends analysis involves dealing with multiple overlapping trends, which will be important to keep in mind as multiple industry transformations occur in the same window of time, with effects that ricochet off one another.

Platforms are dominating the market. In the last quarter of 2017, the world’s biggest retailer, Walmart, had roughly $130 billion USD in revenue. At $60.5 billion, online retailer Amazon made less than half of that amount—yet as of May 2018, Amazon had three times the market capitalization of Walmart. This means that despite currently making half the money of its competitor, the global stock market believes that the future prospects of Amazon are three times better than Walmart’s.

With data over physical assets. Walmart has massive physical stores all over the world, yet the assets Walmart has gathered since its founding in 1962 are seen as less valuable than the expertise, knowledge, technology and raw e-commerce data that Amazon has accumulated since it was established in 1994. Walmart is currently expanding its e-commerce operations to compete.

The new platform companies are geared for research. When the US securities commission tried to ask Amazon about how much it spends on research and development (R&D), amid headlines that the company had spent over $22 billion USD on it in 2017 (far more than any other company in the world), Amazon’s reply boiled down to explaining that this investment also incorporated other content and technology aspects of their operations and was so fused with them that it was impossible to give any kind of meaningful figure. The fusion of R&D into multiple aspects of business operations is one defining characteristic of the digital age and it is becoming increasingly difficult to separate these investments from other aspects of business.
And rival country-wide investments: In 2017, Google’s parent company Alphabet listed its R&D spend at $16 billion USD, while Apple’s was $12 billion USD, collectively hitting new records in R&D spending. To place all these investments in context, OECD figures indicate that in 2015, Australia’s public spending on R&D was a little over 1.8% of GDP, working out to around $25 billion USD. Also according to OECD data Australia’s public investment in R&D experienced modest declines in the lead up to 2015, so it’s likely to today be broadly similar to Amazon’s content and technology figures. The R&D budgets from offshore technology clients will be building advanced digital capabilities that will increasingly compete with Australian companies (large and small).

Going cashless. The nature of transactions is changing in a peer-to-peer economy. When Chinese e-commerce giant Tencent surveyed thousands of its users, it found that over half of them used cash for less than 20 percent of their transactions. Most of the other transactions were not by bankcard, or even by banking apps—they were handled directly by the WeChat messaging app, which has become ubiquitous throughout the country and is now accepted in some locations beyond China’s borders. In Australia, innovation and the development of entire payment ecosystems have been flagged as being crucial to the development of the country’s banking—with transactions contributing around a quarter of the country’s banking revenue. ATM cash withdrawals peaked between 2006 and 2012, and have been declining ever since.

More payment options. The rise of tap and go cards in Australia has occurred at the same time as the rise of cashless payments by smartphones in other regions, providing a convenient alternative and possibly slowing uptake of phone payment systems. Legal efforts from Australian banks to compel Apple to provide access to the Near Field Communication technology in Apple phones—which would have allowed the banks to compete more directly with Apple Pay using Apple phones—have stalled. Instead, Westpac, the National Australia Bank and the Commonwealth Bank have launched their own “Beem It” mobile payment service. The rise of blockchain and cryptocurrency also have far-reaching potential to disrupt this entire sector. It’s already possible to buy and sell goods and services using cryptocurrencies such as bitcoin and litecoin without involving any financial intermediary.

Changing patterns of trust. At their core, Bitcoin and the blockchain technology it is based on, are an attempt to transform the concept of trust. Any traditional payment, be it in cash, cheque or credit card, is based on trusting the institution managing the transaction, the currency used and the economy it is traded in. Blockchain doesn’t ask users to trust any single institution, because every aspect of the transaction has thousands of viewers all over the world, both human and machine, tracking it in real time. The only trust needed is in the reliability of the technology and that other users are watching, which is why experts have called this technology “distributed trust.”

Automating contracts. The applications of blockchain go far beyond cryptocurrencies—already, over a million “smart contracts” exist on the Ethereum blockchain network. These “smart contracts” automatically fulfil an agreement between users when conditions are fulfilled—kind of like a virtual vending machine that responds immediately to a trigger by dispensing a drink, or in this case, cryptocurrency. These kinds of smart contracts have potential applications in almost every sector.

And affecting entire industries. Some companies are already looking at incorporating smart contracts into autonomous vehicles, so cars would be linked on a network and in the event of an accident they could use the data gathered from sensors to immediately resolve any insurance issues. Notably, some companies are explicitly announcing their goal is to remove existing platforms like Uber, on the basis that users could communicate directly with a network of autonomous cars. With the technology still developing, smart contracts are still facing problems with exploits that leave them open to being tampered with but they are still set to affect multiple sectors by introducing automated transactions.
A digitally connected world brings plenty to worry about. Fake news, fake videos, fake people on social media—the stress of determining what is real and the difficulty of keeping up with peers and their airbrushed lifestyles are all taking their toll on public well-being. Billion dollar tech companies, governments and individuals will continue to encounter privacy and data breaches even as ordinary members of the public seek ways to disengage from the negative aspects of digital lifestyles. Meanwhile, there will be a wave of technological and social innovation aiming to improve the safety, security and overall wellbeing of people connected to the digital world.

It’s clear now that we didn’t do enough to prevent these tools from being used for harm. That goes for fake news, foreign interference in elections, and hate speech, as well as developers and data privacy.

- FACEBOOK CEO MARK ZUCKERBERG, GIVING TESTIMONY TO US CONGRESS
In April, global headlines were transfixed on Washington as Facebook founder Mark Zuckerberg gave testimony to US Congress, after months of damaging headlines that cut to the core of how Facebook runs its platform. “This Is Your Digital Life,” a seemingly harmless app that was used by 270 000 people in 2014 and 2015 used Facebook to harvest the personal information of an estimated 87 million Facebook users without their knowledge, and that information found its way to the now shuttered political consulting firm Cambridge Analytica. Former employees of the firm have indicated that this data was used to manipulate the views of voters via targeted advertising and fabricated news reports ahead of the 2016 election. The incident was a powerful illustration of how multiple aspects of the digital revolution — such as data leaks, online manipulation and aspects of social media usage — can converge and have ramifications at the individual, national and global level. “This is Your Digital Life” had, unexpectedly and spectacularly, lived up to the promise of its name by showing the world the hidden aspects of digital lives.

Society will struggle with trust online. Two thirds of Australian youth aged eight to 16 struggle to differentiate fake news from real. Between 2017 and 2018, overall public levels of trust in NGOs, business, government and media all declined in Australia. On the international Edelman Trust Barometer, Australia had the third lowest score out of all countries for trust in social media and search engines in the 2017 to 2018 period. In a rapidly changing digital landscape, the ability of organisations to maintain their credibility will be a core issue that determines success – and this does not just apply to media outlets.

Privacy will be breached. Over 300 000 Australians were caught up in the Facebook data scandal, but it was just one privacy breach among many, with roughly one in 20 Australian internet users reporting in 2017 that they were aware of an incident in which their personal information had been abused. The issue is compounded by the fact that leaks can occur from almost anywhere: banks, hospitals and government departments are among the many organisations which hold sensitive personal information and can be ripe targets for malicious attacks.

With financial repercussions. An IBM report which looked at the cost of data breaches found that worldwide, companies are losing more customers as a result of data breaches. There are positive signs in this area though—in Australia in 2017, the average cost per data breach declined by 2% to $139, when compared to the previous year. Part of this was driven by a decrease in the amount of time it took to locate where and how the data breach had occurred, from an average of 201 days to 191 days.

Governments will respond. In response to the growing threat of data breaches, the Office of the Australian Information Commissioner (OAIC) in February began collecting and reporting on data breaches experienced by organisations, as part of its obligations under the Privacy Act. Already, the figures reveal that breaches occur across a range of sectors, with the healthcare industry topping the first quarter’s figures. Almost half of the 63 breaches were classed as malicious or criminal attacks. The EU is currently rolling out its strictest privacy protection legislation in decades and that will have implications for Australian businesses, and the CSIRO’s Data61 unit will develop Consumer Data Right technical standards over the next four years.

Social media has downsides (as well as upsides). Studies have shown that in many cases, social media usage is associated with declines in well-being. Part of the reason is that it’s easy to fall into the habit of comparing one’s own appearance and lifestyle to the glamorised, curated lifestyles shown on the Facebook profiles of peers, with results that can damage self-esteem, particularly among teenagers. Norwegian researchers have even developed a psychological scale for measuring Facebook addiction.

Digital will distract. When a market research company installed software to track every swipe, touch or tap on 94 people’s smartphones, they found that on average, they touched their phones 2,617 times a day, with the heaviest users at well over 5,000. The ubiquity of smartphones and social media, combined with a global 24/7 news cycle, have made it harder than ever to resist these distractions.
Leading to productivity concerns. The connection between productivity and digital interruptions is not yet well understood, but some companies have already banned Facebook in order to keep employees focused on their work. Two key concerns are regularly expressed—do the distractions have an immediate effect on worker productivity, and in the longer term, do they create more distracted minds that are unable to focus? The debate over digital interruptions, productivity and the gains brought by digital technology will continue to play out over the coming years.

The eyes will play tricks. In April, controversy erupted after former president Barack Obama was shown on camera using an epithet to describe US President Donald Trump—except it never happened. The script was read by comedian Jordan Peele and transposed onto a generated image of the former president. It wasn’t even the first time this has happened to Obama; the technology used to create these fake videos has emerged from a variety of sources—one at the heights of the tech revolution, and one at its depths. A google researcher used 14 hours of real footage to create a fake video of Obama for a TED talk, while reddit user Deepfakes pioneered a less sophisticated version of the same technology by collecting still images of celebrities and creating videos via an algorithm.

And these can be exploited. The Deepfakes subreddit was banned by the platform, but not before the technology became available to the public, and was put to use inserting celebrity faces into pornography. Australian parliament has passed laws to penalise any spreading of revenge porn Deepfake videos, while experts have warned that without global cooperation, even if authentication methods emerge to verify the truth of Deepfake videos, those methods could be studied and faked as well.

Tracking technology holds risks. At the opening event of a world-first anti-stalking unit in London, police suggested a measure which would involve tracking stalkers and notifying their victims when they are in close proximity. Tracking was the suggested solution to a problem also exacerbated by the ease of tracking. Services already exist to mask caller IDs, and GPS services and child-tracking apps can be repurposed by stalkers to hunt their victims. Around 19% of women and 7% of men in Australia are stalked at some point in their lifetime, and as digital technologies become more widely available to the public, it is likely that they will be increasingly used for harassment or physical violence.

All things in moderation. When Facebook’s internal moderation requirements were leaked to the media last year, it became clear that the social media platform was struggling to define comments that constitute unacceptable behaviour. Separating “credible threats” from violent hyperbole is a difficult enough task for police, but it’s even more difficult when operating on a global level. Although they may help or harm, technological solutions will not be able to resolve many of the social issues associated with the need to balance free speech with illegal or discriminatory material, even as they have ramifications in terms of making censorship easier.

Online threats are always changing. The cybersecurity landscape in 2017 included incidents on a scale and frequency never seen before and involved new and evolving malware techniques, such as the global spread of the WannaCry ransomware worm which exploited outdated Windows XP systems and caused over 6900 health appointments to be rescheduled or cancelled in the UK. It is almost certain that threats related to breaches of private data and malicious hacking attacks will grow over the coming decade.
For most of us there’s no unplug option. However, as we become immersed in digital the marginal value of the physical world will rise. We will increasingly crave activities involving objects we can touch and feel along with nature-based experiences and real social interaction experiences. The necessity of visiting a shop, office or university campus will be diminished. But necessity will be replaced by choice. People will visit places they choose to visit. Architects and town planners will need to design buildings and urban environments which attract visitors due to their amenity and beauty. One of the major drawcards for people will be other people. Therefore, successful innovations will be human centred. The best technology of the future will be invisible. We are entering an era of digital humanism.

Science and technology revolutionize our lives, but memory, tradition and myth frame our response.

– HARVARD HISTORIAN ARTHUR M. SCHLESINGER
Many businesses that focus on human experiences are only experiencing limited digital transformation. Despite the arrival of streaming services like Netflix – and the advent of binge-watching as a pastime – movie theatres aren’t struggling to survive. Visitor numbers have remained reasonably stable over the last decade and box office profits have risen even amid slight declines in numbers of theatres\(^{117}\). A digitally connected world does not mean everything will migrate to the cloud, because consumers are still in the market for in-person experiences and hand-crafted products. The experience economy offers new areas for growth, even as certain types of consumption decline.

**Is it just C\(_2\)H\(_5\)N\(_2\)O\(_2\) or is there more to coffee?** In theory baristas should have been automated. It’s a rules based, structured and repetitive job with a well-defined end product. And there are plenty of advanced robotic options that make coffee with little or no human input. But baristas haven’t gone anywhere. In fact it’s a growing profession. Data from the Australian Bureau of Statistics indicate that between 2011 and 2016 there was a 23% rise in the number of people employed as bar attendants or baristas\(^{114}\). So is a cup of coffee at a coffee shop just about getting a drink? Is convenience the priority? Is it the experience? The ambience? A quick conversation? A joke? A smile to brighten the morning? As prices of personal coffee machines have come down it would be reasonable to expect a reduction in coffee shops as people bought more coffee to stay at home. But anyone who regularly travels through urban areas can see that this isn’t the case. Making a coffee is a process that can be automated, but if barista employment is an indicator, customers don’t necessarily want machines. Customers want human experiences that go beyond C\(_2\)H\(_5\)N\(_2\)O\(_2\) (caffeine).

**Peak stuff?** Global furniture retailer Ikea is one of the most powerful symbols of modern capitalism, yet in 2016 its head of sustainability told a conference that the West had probably hit “peak stuff”\(^{115}\). He was indicating that affluent consumers are no longer driven as much by a need to buy physical products, and said that the company would pursue growth through recycling and repair initiatives. Could there be a future where the majority of Ikea sales are for experiences (e.g. entertainment, information, culture and food) rather than furniture products?

**Reflected in an experience economy.** Twenty years after academics in the Harvard Business Review coined the term “the experience economy”\(^{114}\), their analysis remains as relevant as ever. Their description of the experience economy began by tracking investment in a birthday cake over the decades—from mere cents for ingredients, through to cake mixes for a few dollars, before entirely catered parties with cakes thrown in for free\(^{114}\). It was a demonstration of how customers will pay much more for value-adding through services, and how the quality of the “experience” determines what people will pay.

**Digital versus experience.** In the digital era, that lesson is particularly important. More recent analyses have focused on the difference between experiences and services, as well as the nature of interactions between customers and businesses\(^{115}\). Key questions relate to the “emotion” component—businesses that offer face to face, personalised service that makes every customer feel like they had a unique experience have advantages. These advantages are unlikely to be replaced by an increased presence online. Big data offers ways to understand customer needs—up to a point. Beyond that point, face to face interactions are crucial.

**Craft resurgence.** Boutique or artisanal offerings have carved out market niches in recent years, and this is reflected in the craft beer market. According to the Independent Brewers Association, in 2008 there were 81 craft breweries that were “small and traditional”, meeting their criteria for craft beer operations, but by 2016, that figure had risen to 387\(^{116}\). Independent brewers represented just 3% of total beer production, but provided 73% of the employment in the beer industry—with microbrewers and small craft beer pubs representing a significant share. The market for a “beer experience” is growing.

**Cultural participation holds steady.** In 2005 and 2006, 85% of Australians attended cultural venues\(^{117}\). When the ABS checked attendance at the same types of cultural venues for the year leading up to the 2013-2014 period, they found that figure had moved to 86%\(^{118}\). Regardless of the changes brought about by technology, roughly the same proportion of people wanted a day out. Cinemas were the most popular venues to attract Australians, along with libraries, botanical gardens, zoos and aquariums. These categories remained the key categories across the decade, with only slight variations in attendance.

**Digital and physical museums.** Australian museums now have more digital viewers than physical ones—online catalogues and exhibitions attract more views than people walking through the doors. Amid this growth in digital visitors, however, there has been growth in physical visitors as well. The 62 museums included in the Council of Australasian Museum Directors recorded 13% growth in the years between 2008 and 2013\(^{119}\).

**Complementing, not replacing.** This means that people are going digital when they want to see museums, but they also want to walk through those museum doors for a day out. Digital services are complementing brick-and-mortar offerings across a range of sectors and experiencing rapid uptake. Fast food outlets regularly offer consumers the chance to order ahead of time via an app so their food will be ready when they arrive, but this doesn’t fundamentally change the nature of those fast food restaurants, just as Uber Eats may grow and expand where and how it delivers food, but the food offerings themselves can remain the same.
Libraries aren’t going anywhere. Contrary to rumours of their demise, libraries are adapting to the digital era, generally either holding their position or thriving. While there has been a slight decrease in book loans, the number of customers has risen slightly, albeit at a slightly slower pace than overall population growth\textsuperscript{120,121}. Libraries are also expanding alternative offerings, like book depots, kiosks and vending machines. Libraries will have a role in Australia’s digital future, though they are already shifting from being stewards of books to stewards of knowledge and entertainment.

Skills shortages affect uptake. The skill levels of users and their familiarity with technology is a key consideration of any good technology developer. What good is an advanced piece of technology if users can’t or won’t learn to use it? In the US, the agriculture sector has some of the widest gaps between the technology available and the skills of the people who are actually meant to use it\textsuperscript{122}. In Australia, the agriculture sector is seeing skills shortages as farmers struggle to locate specialists that can work with digital agriculture tools\textsuperscript{136}. These kinds of skills shortages will affect the extent to which the digital revolution changes Australia, because if workers can’t use new technologies, the old technologies will continue to dominate.

Offline relationships, online. Tinder may have made the term “hookup app” part of the modern digital lexicon, but Tinder wouldn’t have found such success if humans didn’t have a strong desire for in-person relationships, however brief those relationships may be. Estimates in 2015 indicated that around one in 10 Australians aged 18 to 24 had used Tinder in the month before the poll\textsuperscript{123}. While digital technology will transform the ways in which people communicate, that desire for intimacy will remain and be a driver of technological development, instead of being replaced by it.

What can be monetised? Another key consideration that will determine digital uptake relates to how well technologies can be leveraged for profit. Blockchain, for example, has been enormously successful in cryptocurrencies, which by their very nature can facilitate investment and returns. But at the same time, much of the transformative potential of blockchain lies in the fact it is a radical new form of transparency. Some of its applications are already being monetised and more will be in future, but efforts to unlock some of its disruptive potential could find obstacles if there are already existing, more readily monetised forms of data sharing.

Startups can stop. The vast majority of tech startups fail, with some reports indicating a failure rate of 90\%\textsuperscript{124}. Sometimes these failures are easy to predict, like the spectacular collapse of IoT startup Juicero, whose $399 USD juicers had one key function: to squeeze juice packets that could just as effectively be squeezed by hand. While the Juicero collapse caused mirth among commentators\textsuperscript{125}, other startup failures had more severe consequences. The long-burn downfall of blood testing startup Theranos was an exercise in dogged determination by journalists and whistleblowers who spent months chipping away at the façade of a Silicon Valley icon once valued at $9 billion USD, to reveal that its finger-prick blood testing service did not work as advertised.

And that affects development. As fraud charges were brought against Theranos founder Elizabeth Holmes, authorities told media, “Innovators who seek to revolutionize and disrupt an industry must tell investors the truth about what their technology can do today, not just what they hope it might do someday”\textsuperscript{126}. When plotting scenarios for strategic foresight purposes, a frequently used “axis of uncertainty” relates to technological development or uptake. A key consideration here is whether startups can actually deliver on their promises.

Good technology is invisible. The inventor of the mobile phone, Marty Cooper, is among many technology developers who thinks good technology should be invisible\textsuperscript{127}. This theme regularly crops up in innovation discussions, and essentially means that the technology should be so intuitive, users shouldn’t even need to think about how to use the technology when finishing tasks with it. With this design principle in mind, new advancements may barely be noticed even as they change the technological landscape.
EFFECTIVE DIGITAL STRATEGY – EIGHT INGREDIENTS

The extent of forthcoming change driven by digital transformation is staggering. Just about every geographic region, jurisdiction, industry sector, demography and profession will be impacted. Millions of workers will need to retrain and reposition their careers as digital technology reshapes the labour market. Governments will need to design and implement new policies, regulations and services as society is reshaped. Companies will need to redesign business processes and open new product offerings for different types of customers. There is much opportunity and risk.

In response to these challenges the Data61 Insight team has been working with numerous large and small organisations across our nation and the world on digital strategy problems. Through this work, we’ve identified elements of successful digital strategy that transcend industries, geographies and policy-sectors. In this section of the report we describe eight high-level strategic responses to digital disruption that will help Australian governments, companies, communities and individuals achieve better outcomes.

1. Accelerate
   Remove barriers and reduce friction and reset the cadence of organisational change.

2. Automate
   Develop and implement artificial intelligence for rules-based tasks amenable to automation.

3. Migrate
   Move business processes into digital models where it improves efficiency and effectiveness.

4. Mitigate
   Manage the downsides of cybercrime, fake news, privacy breaches, inequality...

5. Navigate
   Get better at seeing what digital disruptors are coming and respond proactively.

6. Innovate
   Rapidly and continually experiment with new models.

7. Cogitate
   Work smarter not harder. Build a targeted digital R&D pipeline.

8. Gravitate
   Identify and deliver the value your customers and citizens demand.
1. **Accelerate.** This involves removing barriers, reducing friction and increasing the cadence of organisational change to match the fast paced digital world. Many digital technologies are following exponential and/or geometric (as opposed to linear) growth curves both in terms of capability and user adoption/uptake. This means that each year, or month, sees markedly more change than the preceding time period. Platform based models such as Uber, Airbnb, Amazon and others are capable of transforming a marketplace within months and existing companies or industries may not have catch-up time. Australia needs organisational structures, cultures and governance models with increased agility and flexibility.

2. **Automate.** The costs of high powered artificial intelligence, robotics and sensory systems are continuing to decline. These represent more cost efficient, more effective and often safer business processes. For the most part Australia is/organisations are adopting automated systems too slowly given their benefits. The coming decades will see a relentless push by businesses to design, test and implement automated systems. Artificial intelligence can provide more than just an improved way of doing an old process; it can also completely replace the need for entire business functions or operations.

3. **Migrate.** Despite a few decades of digital, a significant number of government and business processes are still conducted via analogue means. Transferring these to digital format can be costly and risky. However, there are many long term benefits and society, especially younger people, have heightened expectation for user-friendly delivery of seamless and often invisible digital services. Organisations need to identify and prioritise business processes which can be converted from analogue to digital. This can be challenging due to the unfamiliar nature of many new technologies (e.g. blockchain). Improved decision support and appraisal frameworks are needed to identify what processes are migrated to digital. The migration strategy also involves a transfer of human skills and aptitudes suited to the digital economy.

4. **Mitigate.** The downsides of digital are well known. These include privacy breaches, cybercrime, online manipulation, fake news, information overload, sedentary behaviours associated with excessive screen time and productivity issues for office workers with numerous interrupts. Many of these problems, especially cybercrime, are worsening at accelerating rates. Any digital strategy needs solutions to these downsides. This includes the replacement of human workers with digital solutions and social equality impacts of digital. The aim is to ensure everyone benefits from the digital transformation.

5. **Navigate.** Theories of recombinant innovation indicate that technological inventions have a multiplicative effect. One technological innovation creates a platform for numerous further technological innovations which in turn enable new platforms for a multitude of technological innovations. This means company boards and policy makers are facing a continually shifting landscape. This calls for improved capacity for anticipatory governance; seeing what lies ahead and taking proactive action. Foresight and digital strategy are two sides of the same coin.

6. **Innovate.** The digital economy lowers the barriers to marketplace entry and decreases the costs associated with designing and testing new business models. This environment is favourable to entrepreneurs. Large organisations in the public and private sector need a changed risk profile and an appetite for experimentation with new technologies and business models. The biggest risk is taking no risk at all.

7. **Cogitate.** The world’s largest companies today such as Alphabet (Google), Microsoft, Amazon and Facebook are set aside from traditional large companies by the amount they invest in research and development which lies in the vicinity of 10-30 percent of total revenue. Governments across the OECD are also ramping up digital research and development. There’s no brute force solution to the digital economy and hard work alone won’t be sufficient. A deeper, new or transformative digital capability can place a company beyond the reach of competitors and quickly consume the bulk of market share. It’s about working smarter not harder in the digital economy.

8. **Gravitate.** As the digital world engulfs everything the marginal value of the physical world rises. Consumers and citizens are likely to place greater emphasis on real human experiences involving social interaction, nature and physical spaces. In this last strategy the importance of gravitating towards the all-important human experience-factor in a digitally immersed economy is emphasised. Often the best digital technologies are invisible and a digital strategy should be wrapped around what people want and need, not the technology itself.
1. Understand core issues and questions
2. Identify patterns of change
3. Identify salient patterns of change
4. Communicate research findings
5. Inform strategic decision making

1. Background study and scope definition
2. Horizon scan to identify trends
3. Screen, classify, validate and prioritise trends
4. Collate and synthesise trends
5. Craft and communicate a narrative about the future
6. Inform strategy, planning and decision making
OUR METHODS – STRATEGIC FORESIGHT

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 making.

Over the past several years the Insight Team housed within CSIRO’s Data61 business unit has developed a generic strategic-foresight process 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 our 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 commences with 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 forthcoming 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.

In the second stage, trends are identified by a horizon scanning process. This casts a wide net over all patterns of change which are potentially relevant to the organisation. The horizon 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 organisation. We sometimes build statistical, mathematical and econometric models to forecast quantitative trends. However, much lies beyond the scope of quantification and is handled via qualitative analysis.

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 checks to ensure trends pass two tests: (a) evidence that the pattern of change is actually occurring and likely to continue occurring into the future; and (b) evidence that it matters to the organisation.

The process of validation often involves checking the proposed trend against datasets, expert opinions and research findings published in journals to ensure accuracy. Sometimes evidence is found both supporting and undermining the trend and the foresight team need 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 which hold significant implications for decision makers. These are captured as building blocks – scenarios, megatrends and risks. 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 has confidence in the results. This description ends at “decision making” but we note an entirely new set of theories, tools and techniques come into play at this point.
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Contact Us

Stefan Hajkowicz
Senior Principal Scientist – Strategic Foresight

stefan.hajkowicz@data61.csiro.au
www.data61.csiro.au

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