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# Skilling for digital disruption and the future of work

# Chair

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# Skilling for digital disruption and the future of work

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# Presenters

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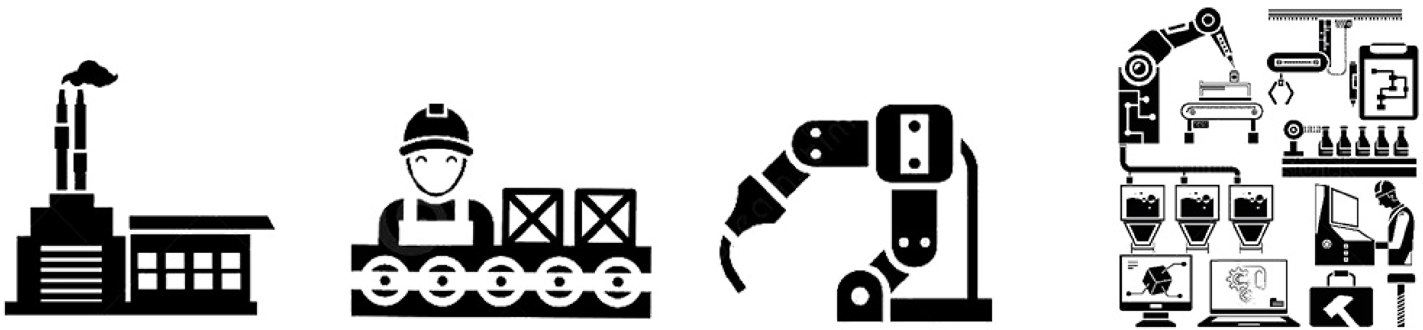
# The changing world of work

- broad perspective on the changing trends in:
  - Technology
  - Economy/labour market
  - Demographic and social

# We've all heard about…

- robots taking our jobs because of automation and changing consumer behavior
- businesses moving offshore and decline of manufacturing
- economies in transition

# Change is not new



18th Century — 19th Century — 20th Century — Today

**Industry 1.0**
Mechanical production equipment powered by steam

**Industry 2.0**
Mass production assembly lines requiring labour and electrical energy

**Industry 3.0**
Automated production using electronics and IT

**Industry 4.0**
Intelligent production incorporated with IoT, cloud technology & big data

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# Difference now is…

- the combination of significant changes occurring simultaneously are amplifying one another
- faster, bigger and exponential shifts

Source: Hajkowicz et al (CSIRO), 2016

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# Technology advancements driving change

- declining costs of technology, increasing capabilities & computational power
- explosion in data volumes and rapid advancements in automation and AI producing robotic devices
- level of routine in tasks now determines a jobs vulnerability

Source: Hajkowicz et al (CSIRO), 2016
Source: AiG, 2018

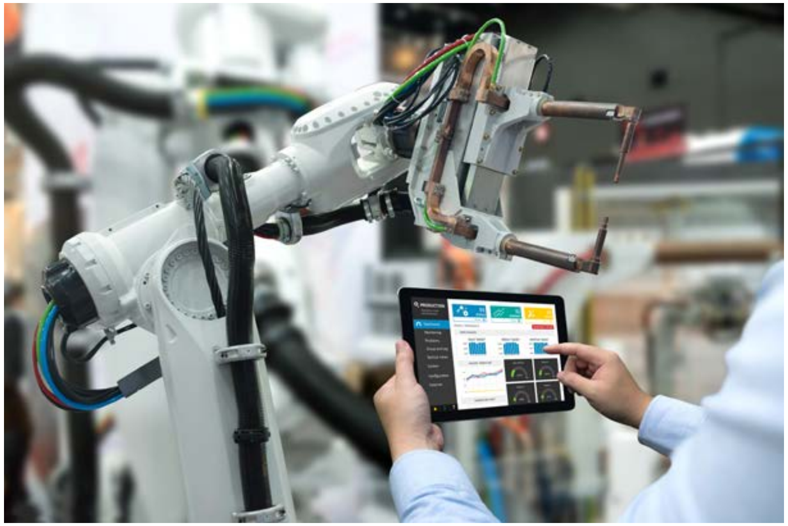
# How many and which jobs could be disrupted?

- great deal of debate
  - CEDA report (2015): highly probable that 40% or 5 million jobs
  - other estimate: around 9% of jobs in Australia at risk of being replaced
  - Productivity Commission: labourers, machinery operators & clerical workers more likely to be disrupted

Source: Cassells et al (Bankwest Curtin Economics Centre), 2018
Source: cited in AiG, 2018

# Perhaps we should ask…

- how will automation change the way we do our jobs?
- analysis of 20 billion work hours each year
  - over the past 15 years, workers reduced the amount of time spent on physical and routine tasks by 2 hours a week



Source: Alpha Beta, 2017

# Extent & pace of technological change

- affected by:
  - technical feasibility
  - cost of developing & deploying solutions
  - size of employer
  - labour market dynamics
  - economic benefits
  - regulatory & social issues

Source: Manika (McKinsey Global Institute), 2017
Source: Cassells et al (Bankwest Curtin Economics Centre), 2018

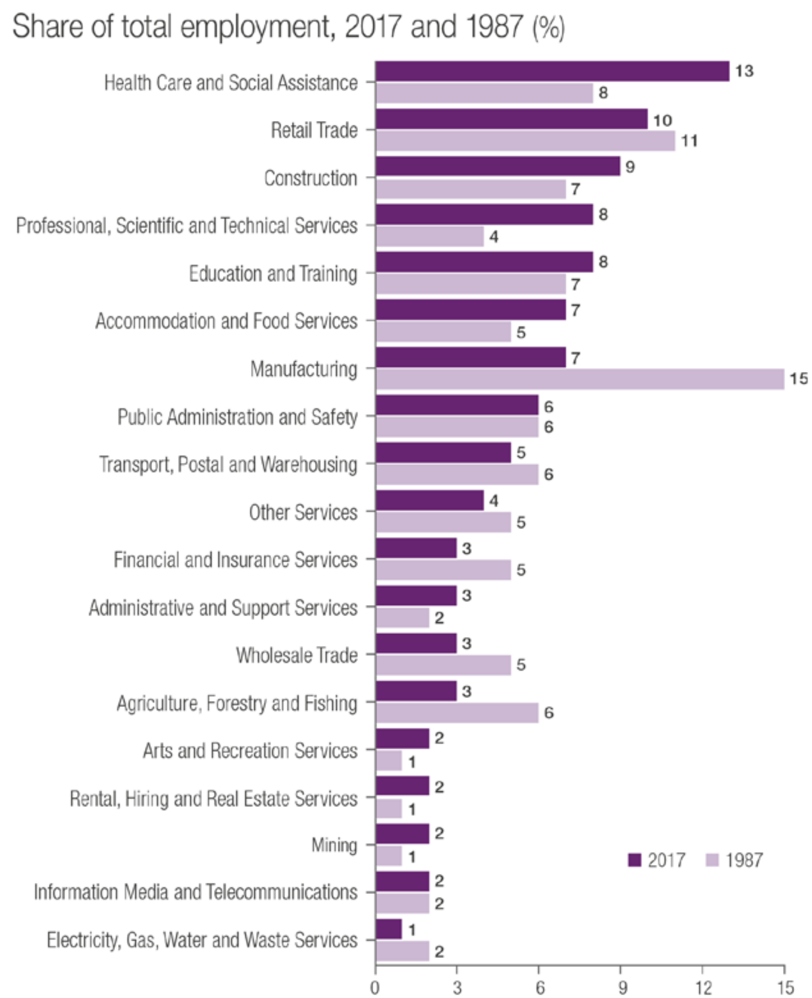
# Economic and labour market changes

- More of us are working compared with 30 years ago
- Increase driven mainly by female participation; male participation has fallen since 1970s
- Nearly a third of all jobs now part-time & about 68% of us are employed in S/M firms

Source: Cassells et al (Bankwest Curtin Economics Centre), 2018, ABS cat no. 8155.0: 2016/2017

# Change at industry level

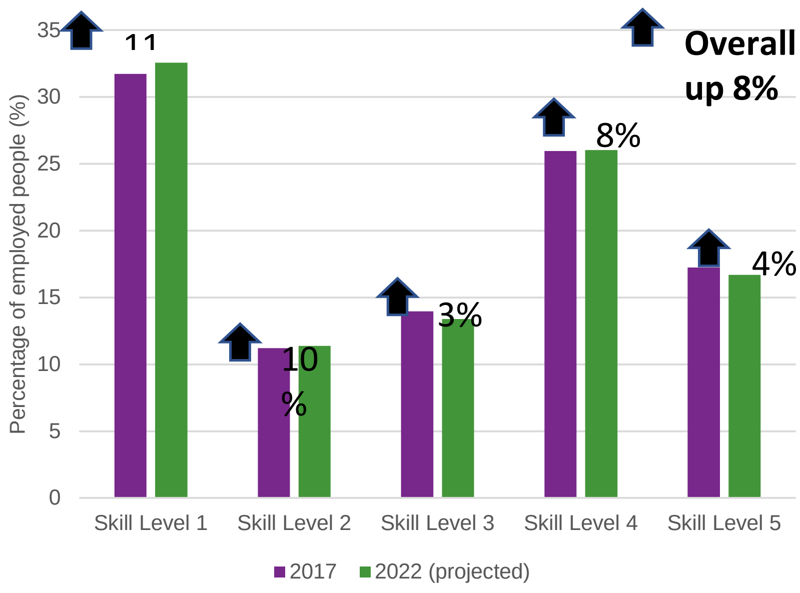
- 'Australia no longer makes things, it services people'
- shift to the service economy is a key reason for contrasting trends in male and female employment




Source: Cassells et al (Bankwest Curtin Economics Centre), 2018
(right) graph from *Australian Jobs 2018*

# Change at the occupation level

- Professional workers account for nearly a quarter of occupations
- Machinery operators & drivers and labourers declined
- if trend continues, ongoing demand for higher-level skills




Source: Cassells et al (Bankwest Curtin Economics Centre), 2018
(graph right) Source:

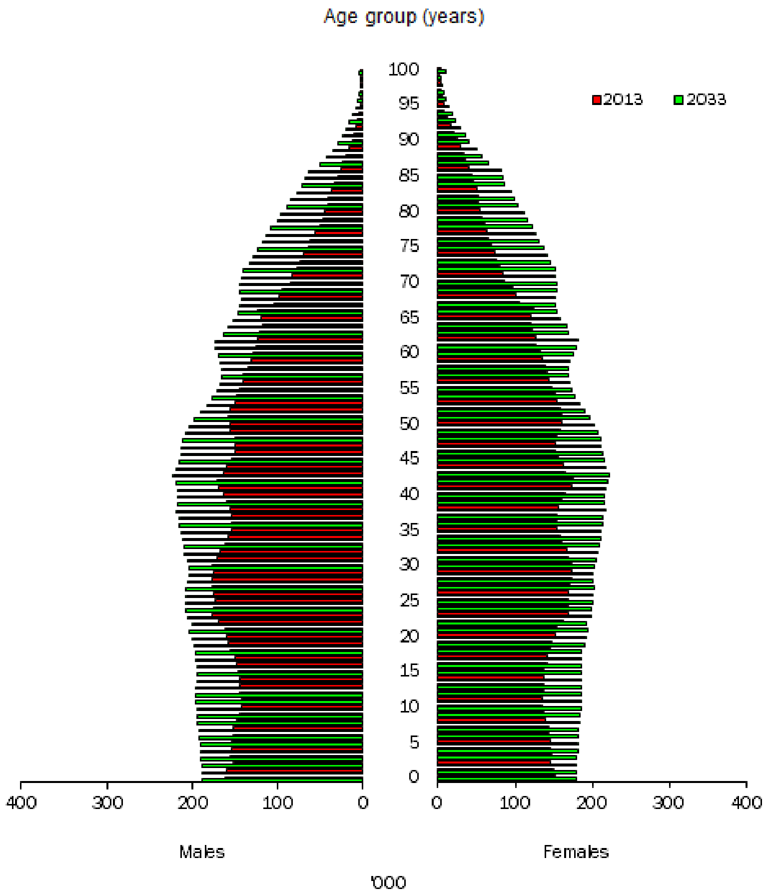
# Employment & organisational structures are changing

- more people are moving from formal to independent employment or contract work
- Freelancer.com connects over 28 million employers and freelancers globally
- about 1 270 000 or 11.6% of Australian workforce are independent contractors

Source: Cassells et al (Bankwest Curtin Economics Centre), 2018

# Demographic and social changes

- we're living longer
- more than half of Australia's population growth has come from migration
- this will mean we are working with people across diverse age groups and cultural backgrounds




Source: Allen et al (AISC), 2018
Source: Hajkowicz et al (CSIRO), 2016
Source: ABS, 4102.0

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# The Fourth Industrial Revolution

## The implications of technological disruption for Australian Vocational Education and Training (VET)

Pi-Shen Seet, Edith Cowan University
Janice Jones, Flinders University
John Spoehr, Flinders University
Ann-Louise Hoardacre, Flinders University

AUSTRALIA ECU EDITH COWAN UNIVERSITY

Flinders UNIVERSITY

# Agenda

- Background to research
- Research Question and Objectives
- Literature review
- Research findings
- Case studies
- Summary and ways forward
- Q & A

# Background to research

- Technological innovation is a main engine for long-run sustainable economic development (Drucker, 1985; Schumpeter, 1942)
  - Esp. that of radical and discontinuous innovations (Christensen, 1997; Huggins et al., 2009).
- Innovation and change has in the past often been linked to changes in work and employment (Nelson et al., 1966).
- Emerging developments in technology anticipated to have rapid and major disruptions due to the multiplier effect of technologies interacting with each other in a so-called Fourth Industrial Revolution (WEF, 2016).
  - e.g. Nokia's loss of 24,000 employees in the last 15 years due to disruption by smart phones) (Ewing et al., 2015; Hajkowicz et al., 2016).

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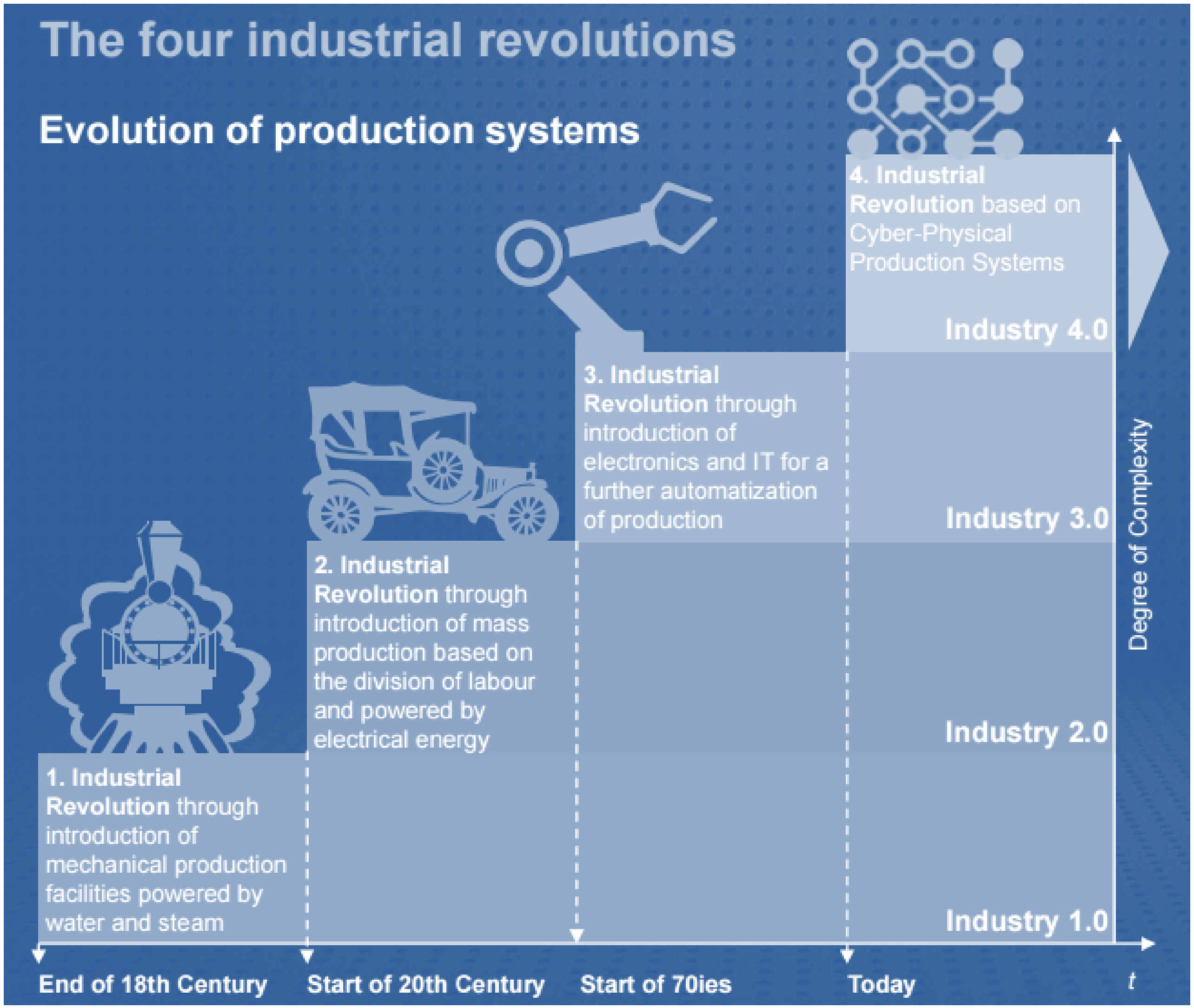
# Twelve disruptive technology categories identified by the McKinsey Global Institute

(Manyika et al., 2013).

| | |
|---|---|
| **Mobile Internet** | Increasingly inexpensive and capable mobile computing devices and Internet connectivity |
| **Automation of knowledge work** | Intelligent software systems that can perform knowledge work tasks involving unstructured commands and subtle judgments |
| **The Internet of Things** | Networks of low-cost sensors and actuators for data collection, monitoring, decision making, and process optimization |
| **Cloud technology** | Use of computer hardware and software resources delivered over a network or the Internet, often as a service |
| **Advanced robotics** | Increasingly capable robots with enhanced senses, dexterity, and intelligence used to automate tasks or augment humans |
| **Autonomous and near-autonomous vehicles** | Vehicles that can navigate and operate with reduced or no human intervention |
| **Next-generation genomics** | Fast, low-cost gene sequencing, advanced big data analytics, and synthetic biology ("writing" DNA) |
| **Energy storage** | Devices or systems that store energy for later use, including batteries |
| **3D printing** | Additive manufacturing techniques to create objects by printing layers of material based on digital models |
| **Advanced materials** | Materials designed to have superior characteristics (e.g., strength, weight, conductivity) or functionality |
| **Advanced oil and gas exploration and recovery** | Exploration and recovery techniques that make extraction of unconventional oil and gas economical |
| **Renewable energy** | Generation of electricity from renewable sources with reduced harmful climate impact |




Source: WEF (2016), Accenture (2016)

Systems are being transformed – not specific products or services

**Cyber physical systems** combine communications, IT, data and physical elements integrating a number of core technologies:

—Sensor networks (receptors)

—Internet communication infrastructure (IP)

—Intelligent real-time processing and event management (CPUs)

—Actors for mechanical activities

—Embedded Software for logic

—Big Data and Data Provisioning

—Automated operations and management of system activities

—Advanced Robotics

—3D/4D Printing

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## Historical Industrial Revolutions:

**1st:** 1784
Steam, water, mechanical production equipment

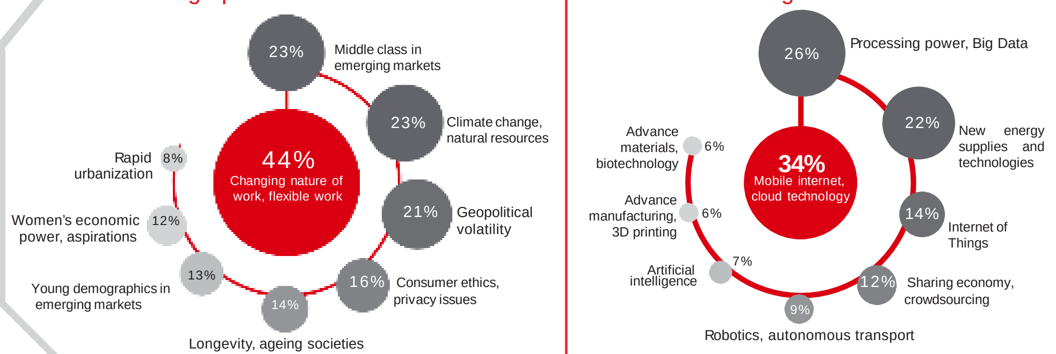
**2nd:** 1870
Division of labour, electricity, mass production

**3rd:** 1969
Electronics, IT, automated production

**4th: ??**
Cyber-physical systems

Source: World Economic Forum

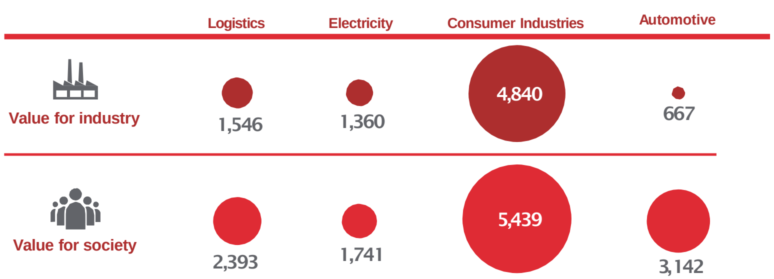
## Drivers of 4th Industrial Revolution:




Source: World Economic Forum, Future of Jobs Survey 2016

## Impact on Key Industries:

Impact of Digital Transformation until 2025 (USD BN)




Source: World Economic Forum, Accenture analysis

## Future Workforce Strategies:

Share of respondents pursuing strategy (%)

**65%** Invest in reskilling current employees

**39%** Support mobility and job rotation

**25%** Collaborate, educational institutions

**25%** Target female talent

**22%** Attract foreign talent

**22%** Offer apprenticeships

**14%** Collaborate, other companies across industries

**12%** Collaborate, other companies in industry

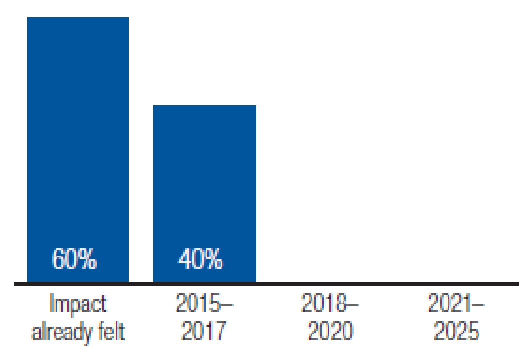
**12%** Target minorities' talent

**11%** Hire more short-term workers

Source: World Economic Forum, Future of Jobs Survey 2016

## Disruption in Focus: Changing Nature of Work, Flexible Work

Expected Time to Impact on Employee Skills




Sources: WEF (2016), HSBC (2016)

Digital Disruption: What do governments need to do?

Productivity Commission Research Paper

June 2016



# Digital disruption could threaten 40 per cent of jobs, says Productivity Commission

The World Today By AM business editor Peter Ryan

Posted 15 Jun 2016, 11:23am

**Digital disruption has the potential to threaten 40 per cent of jobs over the next 10 to 15 years as automation and machine learning shake up the economy, according to a Productivity Commission report out today.**

In research entitled Digital Disruption: What do governments need to do?, the Commission warned that governments and regulators need to prepare for changing times as "disruption" moves beyond Uber and Air BnB.

Productivity Commission chairman Peter Harris said developing disruptive technologies of machine intelligence and automation will gradually change economies.

"There's little doubt that in some sectors there will be dislocation of labour and dislocation of capital.

"It's not just a cost to employees, it will be a cost to certain businesses as well," Mr Harris told The World Today.

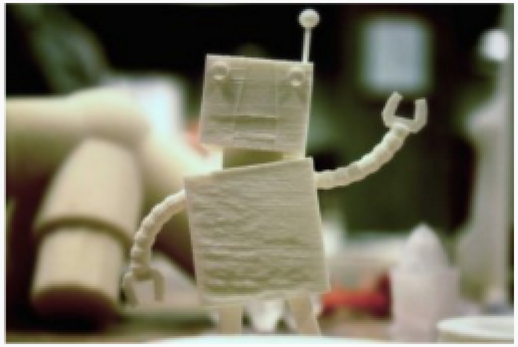


PHOTO: A small robot produced on a 3D printer at the Architecture and Design School in Oslo. (Flickr: Mads Boedker (CC-BY))

MAP: Australia

## Key points:

- Machine intelligence and automation will gradually change economies
- Fears about humans being replaced by


- Tourists are money: Sex Pistols impresario's son to burn memorabilia
- Wasleys residents commemorate first anniversary of Pinery bushfire
- Government agency to move to Deputy PM's electorate
- Victorian Govt forced to back down over Christmas public holiday
- PNG Govt raises candidacy fees ten-fold ahead of April 2017 election

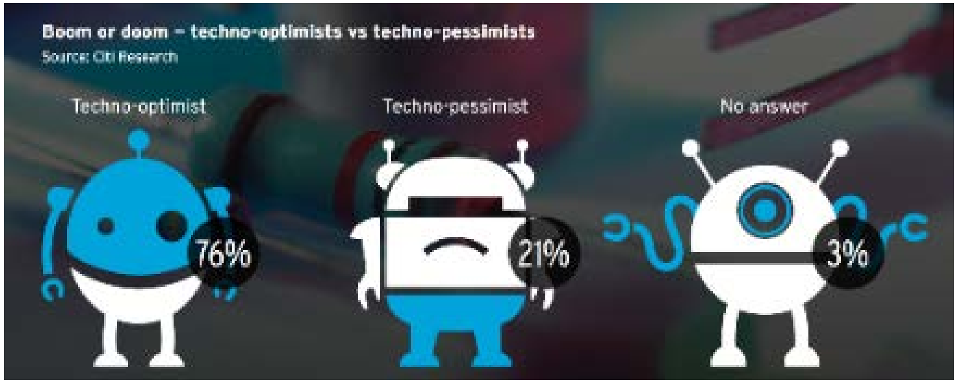
More

## TOP STORIES

- Australia triumphs at last with emphatic win over Proteas
- Women pushed onto train tracks in 'crazy' Melbourne knife attack
- Government can't keep using 'borrowed money', Abbott says
- Baby pygmy marmoset found alive, two men arrested

# Consensus or Not?

- Growing consensus
  - the impact of disruption to business models,
- Lack of consensus




  - These technologies offering limitless new opportunities versus those who see major job dislocation (ICAANZ et al., 2016; Dolphin, 2015).
    - “The fourth industrial revolution has the potential both to increase economic growth and to alleviate some of the major global challenges we collectively face.” (Schwab, 2016: 35)
    - “Invention since 2000 has centered on entertainment and communication devices that are smaller, smarter, and more capable, but do not fundamentally change labour productivity or the standard of living in the way that electric light, motor cars, or indoor plumbing changed it.” (Gordon 2012: 9)

# Research Question and Objectives

- **To examine the relationship between disruptive technologies and skill development needs in the VET sector from the perspective of industry (technology users) and innovators (technology producers)**

- Objectives:
  1. What is the **nature of the relationship between disruptive technologies and demand for skills**?
  2. To what extent are **specialist skills versus generic skills** relevant to the implementation of disruptive technologies?
  3. To what extent **is there consensus** between the technology innovators and end-use employers when it comes to skills acquisition/development for disruptive technologies?
  4. What are the **barriers to VET students' and graduates' skill acquisition and development** in the next five to 10 years in the context of disruptive technologies?

# Literature review: disruptive technology and its impact on jobs, work and skills

- Disruptive technology effects are relative and **do not affect all players in the market equally**: they may be 'disruptive to some but sustaining to others' (AlphaBeta 2017; Bower & Christensen 1995).

- While some research (e.g. Durrant-Whyte et al., 2015) has argued that around half of all jobs are susceptible to the impact of automation (in that tasks are potentially automatable), **less than 10 percent and as few at 5 percent are potentially totally automatable** (Australian Industrial Transformation Institute, 2017)

- **3 alternative scenarios** of automation (Hirsch-Kreinsen, 2016):
  - Technology-centred scenario
  - Hybrid scenario
  - Specialisation scenario



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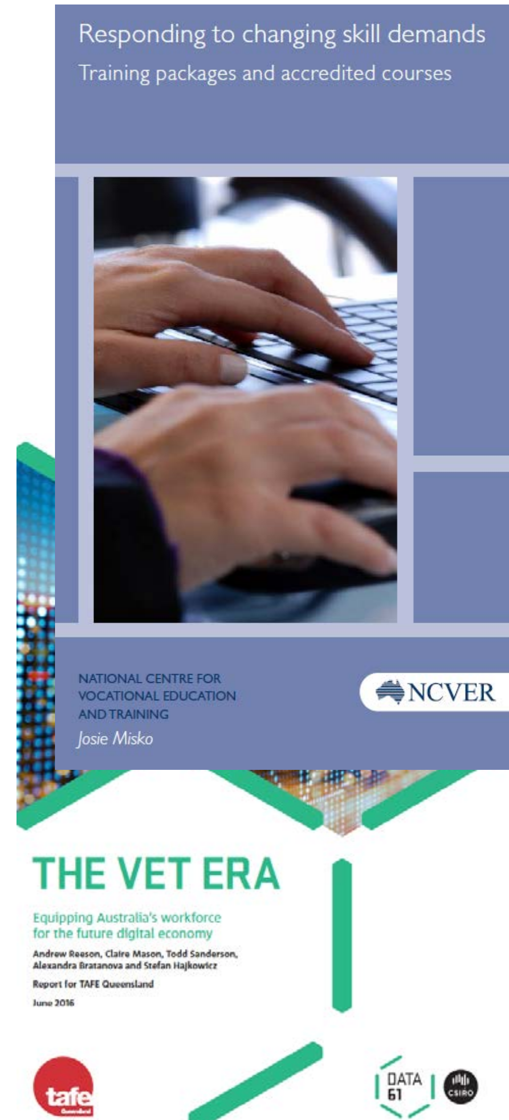
# Literature review: Prime Minister's Industry 4.0 Taskforce & Skills for Australia

| Digital skills | Project coordination skills | Soft skills |
|---|---|---|
| Industry 4.0 programming and software engineering | Product management | Creativity |
| Data science | Multi-project management | Design |
| Data/ big data analytics | Supply chain and support services | Innovation |
| Visualisation | Logistics | Leadership |
| Internet of Things | | |
| IT architecture | | |
| Security | | |

Source: Subic & Gallagher, 2017

# Literature review: Disruptive Technology and VET

- Technology can change rapidly, sometimes within the timeframe of a student’s training course, creating a risk that they may graduate with skills that are no longer relevant to employers (Reeson et al. 2016).
- Too much bureaucratic red tape and unnecessary detail mean that the existing VET system is sluggish in responding to emerging needs in a timely fashion (Misko 2010).
- VET trainers need to be exposed to current and emerging technologies by undertaking training and development to enable them to be competent technology users as well as educators (Reeson et al. 2016).



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# Research Method

- Phase 1: Semi-structured interviews with 23 CEOs/ CTOs firms in industrial sectors identified as likely to be significantly affected by disruptive technologies
  - Advanced manufacturing
  - Information technology (IT)
- Phase 2: Interviews with 18 key VET sector stakeholders
- 2 case studies
  - Industry: REDARC
  - VET sector: Factory of the Future Testlab

# Findings 1: The relationship between disruptive technologies and demand for skills

- A **reduced need for particular jobs**
  - *a fully automated line controlled by two operators, whereas previously, we had four operators … we still need operators obviously to make sure that the line is running correctly and do any changeovers or things like that.* *(Firm #2)*

- **Changed the nature of existing jobs** and in doing so has **expanded the range of tasks**, such as problem-solving and collaboration, creating the need for additional skills and knowledge.
  - *they'll have programming skills … knowledge of digital design and hardware design, but in general they won't have the simulation-creation or even simulation-use skills … there's two levels of skills there: there's someone who can use a simulator instead of using a physical prototype and then there's people who develop the simulators. So they need to be able to look at a data sheet or specification from a piece of hardware and develop a model for it. (Firm#9)*

- While **larger firms implement in-house training** to help fill gaps, including those that exist in VET courses, **smaller firms tend to hire workers with the required skill set**.
  - *the … dichotomy is that … you've got large companies … the big facilities [which] are great for in-house [training] but … the Australian dynamic, it's lots of small, sometimes single, sole trader, employers [who] might have one apprentice … the apprentice won't get the full range of learning that's required just in that situation. (VET#10)*

# Findings 2: Specialist skills versus generic skills for disruptive technologies

- **Specialist technology-related skills** are important from a range of engineering disciplines, as well as software development and computer programming
  - *from physicists, signal engineer, signal technologist, mechanical engineers, electronics engineers, industrial designers, manufacturer engineers, process engineers, technicians, production workers, procurement specialists, export specialists, planners … we … cover the whole gamut, including … IT specialists … ERP [Enterprise Resource Planning] specialists … software engineers. (Firm#3)*

- Firms viewed **higher-level technological skills as more valuable** than employees with VET qualifications.
  - *… an apprenticeship now is … the base level of where we want to train someone … we want to be able to … have a person go from an apprenticeship right through to advanced diploma and then … for instance, into a university degree … (Firm #2)*

- **Importance of generic non-technical skills** and competencies to include teamworking, creativity and problem-solving to explore and deploy technologies effectively in workplaces.
  - *Equally important is their … softer skills, their people skills and how they fit with the team … the attitude of learning and … continuous development, that's really important … the world moves on … That continuous learning skill is critical.(Firm#5)*

# Findings 3: Perspectives on skills development for disruptive technologies

- Consensus among technology innovators and employers on the need to enhance skill development for disruptive technology
  - But when considering specific technologies, there is **substantial uncertainty about the skills needed and how the training should be delivered**.
    - *We found with the NBN we geared up probably 2—3 years ago thinking, oh, NBN we'll get there ready to go, it's just starting to roll out now. So in terms of that lag lead time, … the actual people that are doing it will probably be the same but it's just what they're doing that's different.  (VET#02)*
- Sometimes the drive to train for the use of disruptive technology does not come from industry or the VET sector, but **from the students themselves.**
  - E.g. drone technology (low costs leading to many hobbyists), resulting in its adoption in a VET sector course.
    - *We've done some work with our surveying students and … they're starting to use a lot of drones … our courses … need to be doing that … to enable them to use drone technology to do surveying.        (VET#01)*

# Findings 4: Barriers to VET students' skill acquisition and ongoing skill development

- **Employee skills gaps**: Firms drawing attention to STEM, technical and non-technical skill gaps among both VET students and university graduates
  - *the problem is that disruption is outpacing our education system … literacy and numeracy … [are] actually going [backward] … what we are having to do is run our own internal training sessions for all of our young people … taking engineering staff off the job to actually train our younger staff because they are not coming out of the school system with the right level of STEM … we run a session … every Friday afternoon for two hours with our apprentices, it's voluntary … it's in work time, basically coaching them to get through a trade … because I've had students failing subjects at TAFE and … that's a … major issue for Australia for our competitive advantages about talent. (Firm#2)*

- Some employers reported difficulties in **finding public and/or private providers with the capacity to provide education and training in specific disruptive technologies.**
  - *no one at TAFEs, no one at universities is teaching the stuff that's needed to be known at the moment (Firm#8)*
  - *our people are upgrading their skills externally and through us in training courses … but … also we leverage local industry capabilities like in additive manufacturing … and in some cases we will leverage our parent company to bring training to Australia and provide that training. (Firm#6)*

# Specific challenges of disruptive technologies for VET

- **Weak Industry—VET sector—University linkages and collaborations**
  - I've pushed the idea before, it's … finding our way through both the university and TAFE bureaucracies to make that happen … we would love to be doing some of that work with the universities, because the university's strong point has always been the theoretical … TAFE's strong point has always been the practical … That seems complementary to me. (VET#01)

- **Reduced resourcing, organisational changes and policy uncertainty**, combined with the **limitations of training packages,** saw many VET trainers perceiving that they lacked capacity to prepare themselves and students for disruptive technologies.
  - *definitely time for training … [and] getting staff is a very difficult one … there're a lot of overheads … which make it very difficult to get lecturers … and it's not a job I would actually recommend to anyone … I don't know where we're going to go for [staff] in the future, the more technology we get the more we've got to train and it's never-ending. (VET#07)*
  - *So within training packages, the units and modules … limit us in what we can do and how we can interpret that … for example, if I want to incorporate something, and I search my training products, it's limited because they will say in this training package, you can only bring in one extra elective and that has to be within this context. So I can't teach entrepreneurialism to my engineering students because the training package has nothing in it. (VET#04)*

# Case study 1: REDARC


- Seeking a workforce **skilled in computer systems, electronics, mechanical/mechatronics, materials skills and chemical engineering**.

- Commenced preparing employees to become Industry 4.0-ready by:
  - Engaging one of the **German-based Fraunhofer Institutes** to run dedicated sessions on Industry 4.0 capability-building,
  - Sending staff to conferences and engineers to **Japan to study lean manufacturing and Industry 4.0-compatible machine lines**.

- In education and training, CEO Anthony Kittell considers it important to
  - Develop the application of an **overarching Industry 4.0 lens across the core competencies.**
  - There is a need for "*some sort of **intensive fast track program** for the people that deliver these courses so that they are actually brought up to speed with what's happening*"

# Case study 2: Swinburne's Factory of the Future

- Key platform for developing and teaching Industry 4.0 technologies in a **state-of-the-art facility providing strong links across the higher education, research, vocational training and manufacturing sectors.**

- Recently collaborated with Ai Group and Siemens to develop the **Industry 4.0 Apprenticeship Program**.
  - 19 students participated in trial, culminating in a **Diploma in Applied Technologies**.
  - Training was provided in **cutting-edge manufacturing technologies**, including **3D metal printing, machine vision and virtual reality applications**.
  - These skills are considered necessary to enable graduates to **respond to disruptive technologies in all industries**.


# Summary and ways forward

- Training solutions should be developed that allow for the expanded scope of tasks in existing jobs/ roles/ positions.
- Equally important is to enhance development of ‘generic’ or soft skills
- The disruptive nature of some advanced technologies has implications for VET planning, offerings and delivery.
- The VET sector and employers need to work together to support the updating and upgrading of the lifelong learning skills of VET graduates.
- Recent moves towards developing cross-industry units, skill sets and qualifications, and their adoption across multiple industries, will help to address changes from rapid digitalization and needs to be accelerated.

# Thank you

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    - https://www.aph.gov.au/DocumentStore.ashx?id=2ee99af1-9f11-43c7-9791-e2cb2b8f8278&subId=563771

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