The Fourth Industrial Revolution and its Impact on Skills, Training and Learning

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NCVER

Agenda

- Background to research – The Changing World of Work
- What is the Fourth Industrial Revolution
- Existing research
- Research Question and Objectives
- Research findings
- Case studies
- Summary and ways forward
- Q & A

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

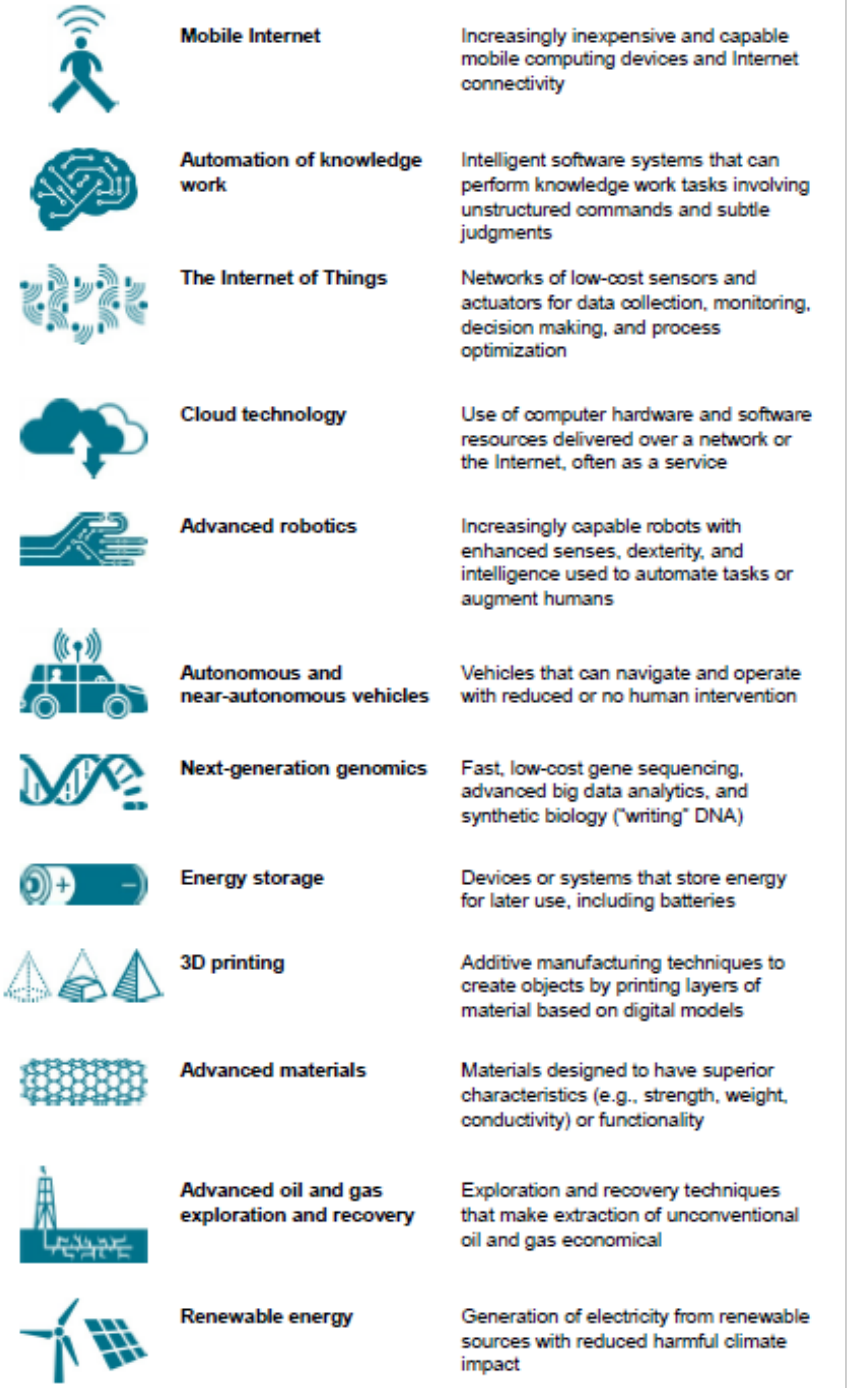
Activity 1: Will Robots Take My Job?

- Go to the following websites:
  - https://willrobotstakemyjob.com/
  - http://www.abc.net.au/news/2017-08-08/could-a-robot-do-your-job-artificial-intelligence/8782174
- Key in your job
  - What do they show?
  - Do you agree? Why/ Why not?
  - Discuss with the person next to you about your findings.
  - Tweet your results to #willrobotstakemyjob

Technological Innovation and Change

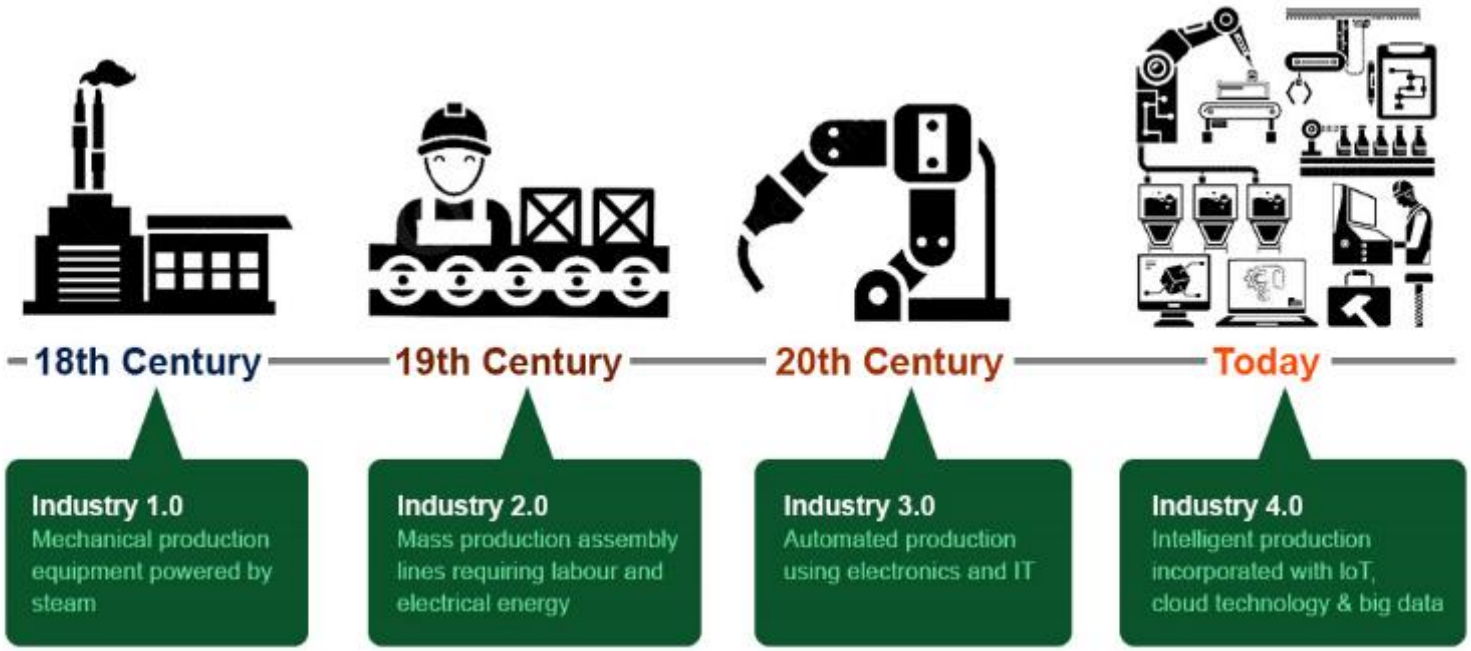
- Technological innovation is a main engine for long-run sustainable economic development (Drucker, 1985; Schumpeter, 1942)
  - Esp. that of radical and discontinuous innovations (Christensen, 1997; Huggins et al., 2009).
- Innovation and change has in the past often been linked to changes in work and 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).

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

Change is not new

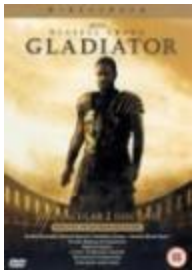


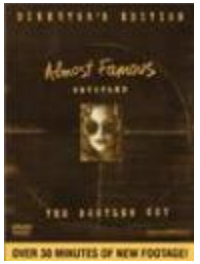
https://www.youtube.com/watch?v=Ko2esJeGsrI&list=PL7m903CwFUgnP-IIuBRhBYGkN0ImPefAE&index=7

#WEF #4IR

Activity 2 – Back to the Future …

- What was the most watched movie of 2000?
  - The Gladiator
  - Erin Brockovich
  - Chocolat
  - Crouching Tiger, Hidden Dragon
  - Almost Famous
- How many people did it take to create the most watched movie of 2000?
  - 6
  - 60
  - 600
  - 6000
  - 60,000
  - 600,000





- What was the budget for the most watched movie of 2000?
  - US$3
  - US$30
  - US$300
  - US$3,000
  - US$30,000
  - US$300,000
  - US$3,000,000
  - US$30,000,000
- Answer

- $140 of the budget paid the fines of two traffic tickets for walking on the highway shoulder while filming
  - issued by California Highway Patrol Officer Dana Anderson, who is listed in the "Special Thanks" section of the credits
- Week 1: more than 10,000
- End of 1st month: two million views.

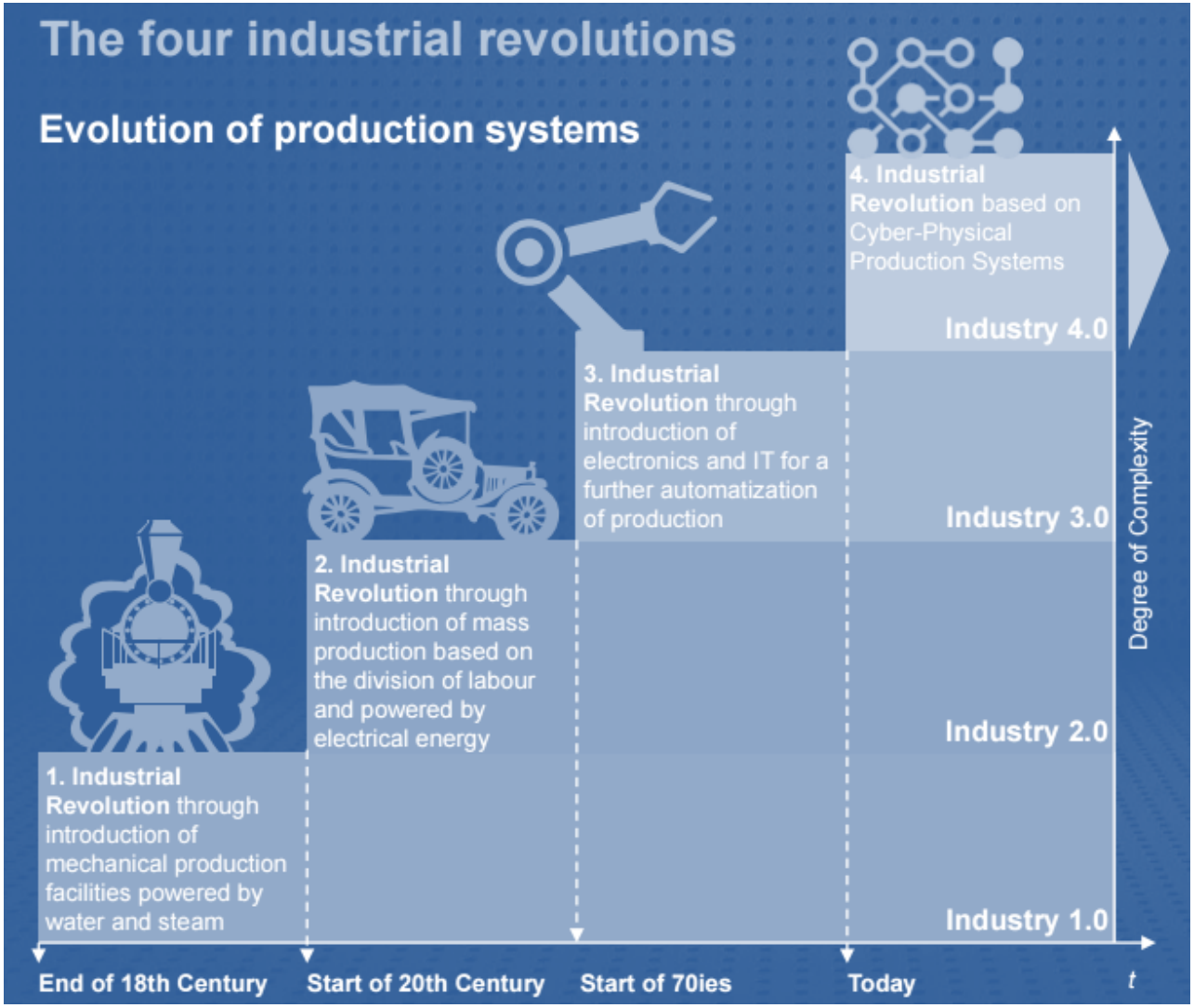
405	
Directed by	•Bruce Branit •Jeremy Hunt
Written by	•Bruce Branit •Jeremy Hunt
Starring	•Jeremy Hunt •Angela Burns •Erin Kotecki
Music by	Wayne Boon
Production company	Lucamax Pictures
Release date	•June 5, 2000
Running time	180 seconds
Country	United States
Language	English
Budget	US$300[1]

How did this movie/ video disrupt skills, learning, and work in the entertainment industry and beyond?

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



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

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

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:

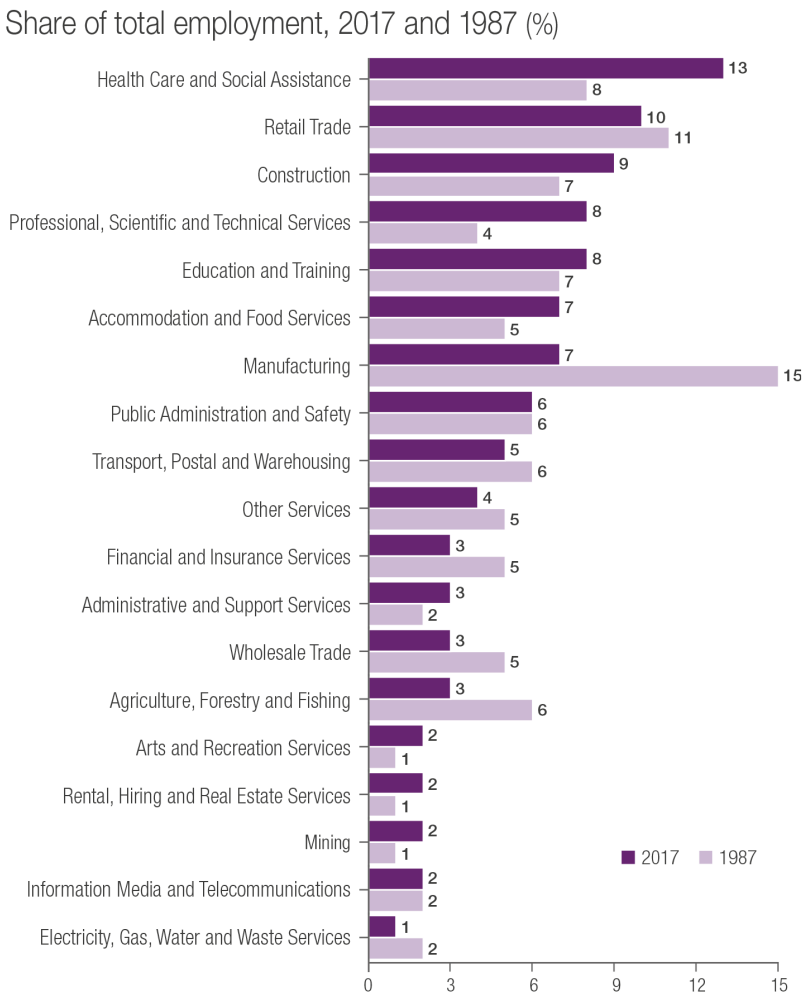
2016/2017

Impact on Australia

- Great deal of debate
  - Productivity Commission
    - laborers, machinery operators & clerical workers more likely to be disrupted
  - Other estimate
    - around 9% of jobs in Australia at risk of being replaced
  - 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

Change at industry level

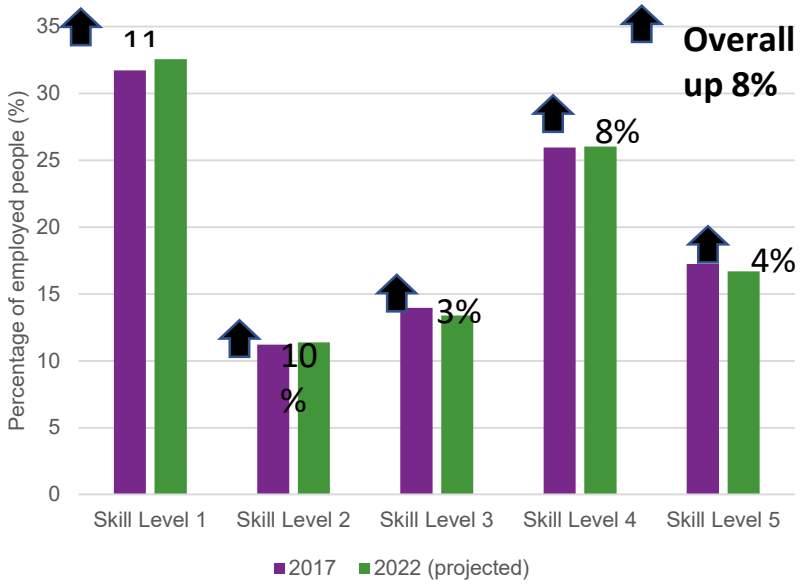
- ‘Australia no longer makes things, it services people’
- shift to the service economy is a key reason for contrasting trends in male and female employment



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:

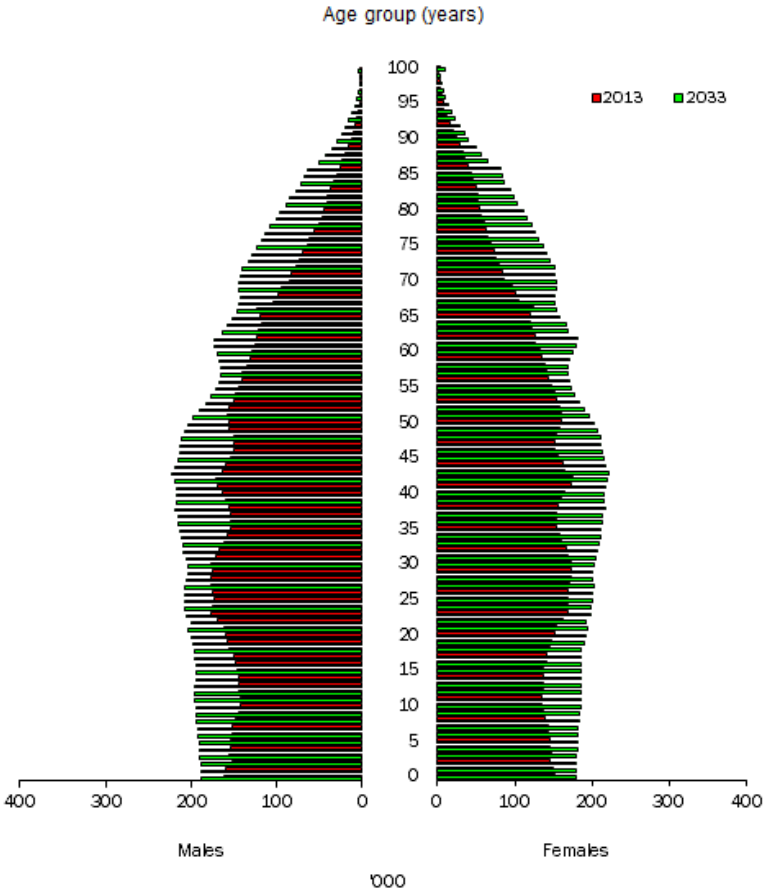
Employment & organisational structures are changing

- 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

Summary of Drivers and Impacts of i4.0

Historical Industrial Revolutions:

1st: 1784
Steam, water, mechanical production equipment

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

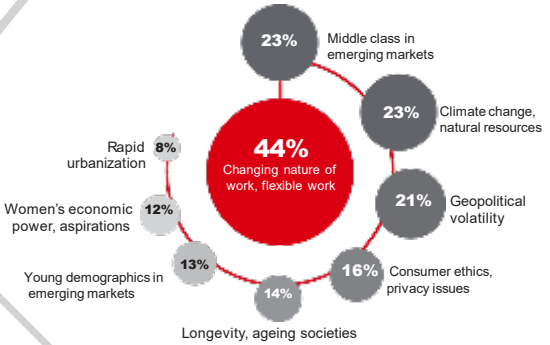
3rd: 1969
Electronics, IT, automated production

4th: ??
Cyber-physical systems

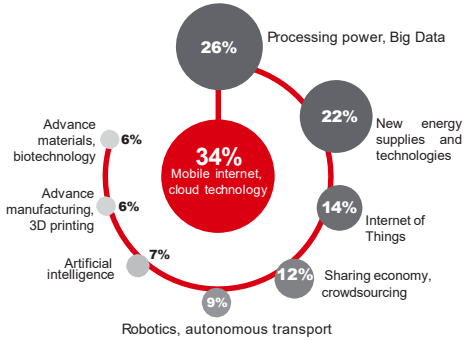
Source: World Economic Forum

Drivers of 4th Industrial Revolution:

Demographics & Socio Factors



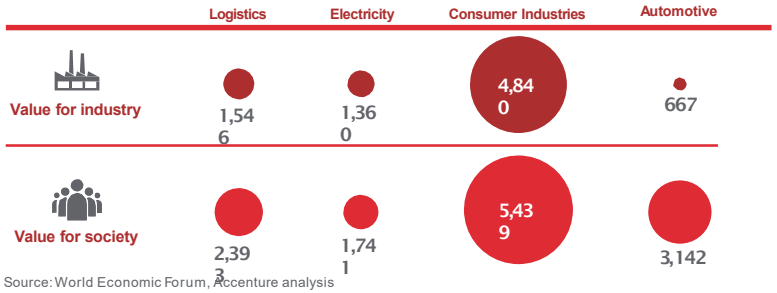
Technological Factors



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:

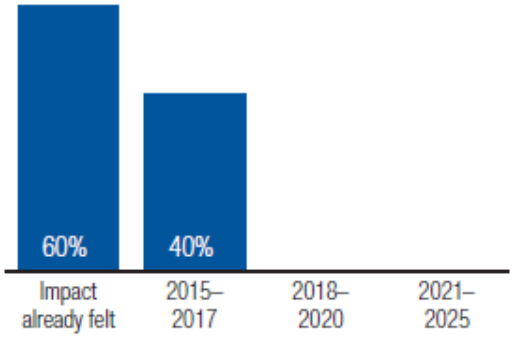
Share of respondents pursuing strategy (%)

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

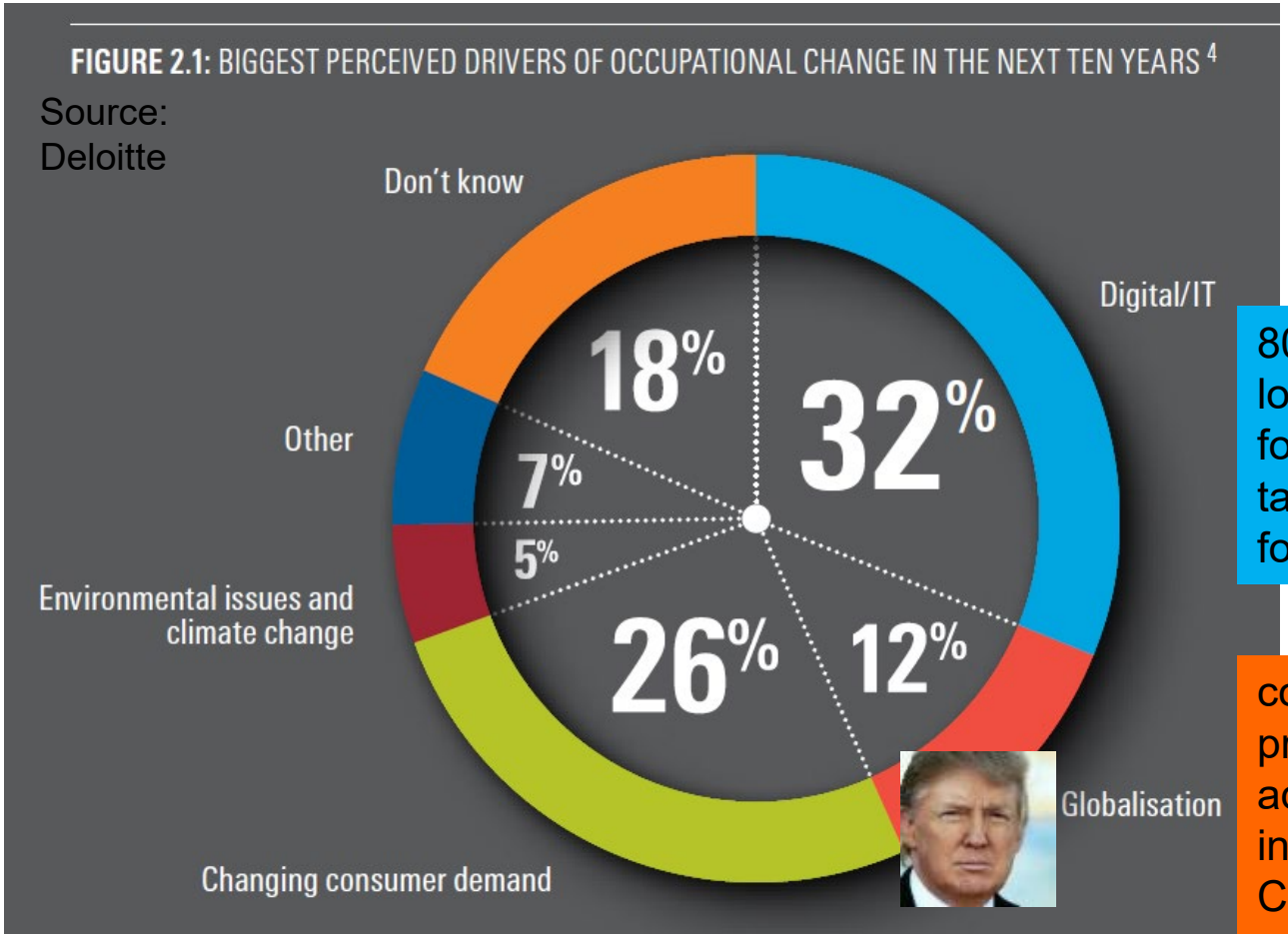
Disruption in Focus: Changing Nature of Work, Flexible Work

Expected Time to Impact on Employee Skills



Sources: WEF (2016), HSBC (2016)

Perception and Reality

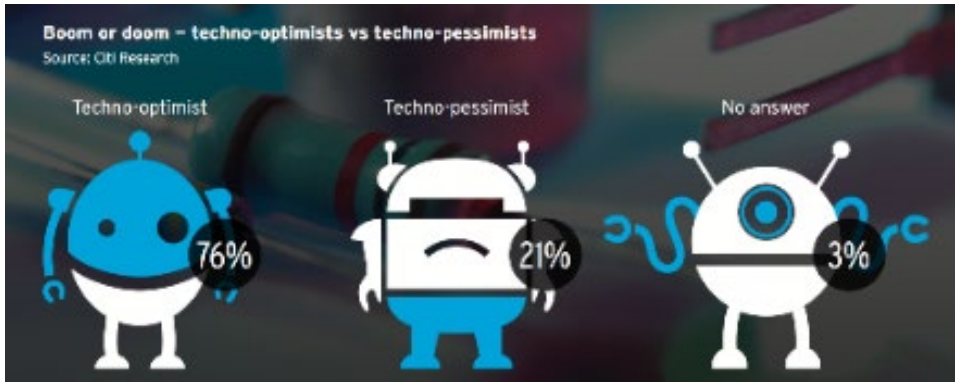


80% of manufacturing job losses since the 1970s, he's found, have actually been taken by robots and other forms of automation.

companies moving their production overseas to take advantage of low labour costs in places like Mexico and China

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)

What about among Academics?

Agriculture, forestry and fishing, and arts and recreation services are much more precarious for their employees. KATE AUSBURN/AAP

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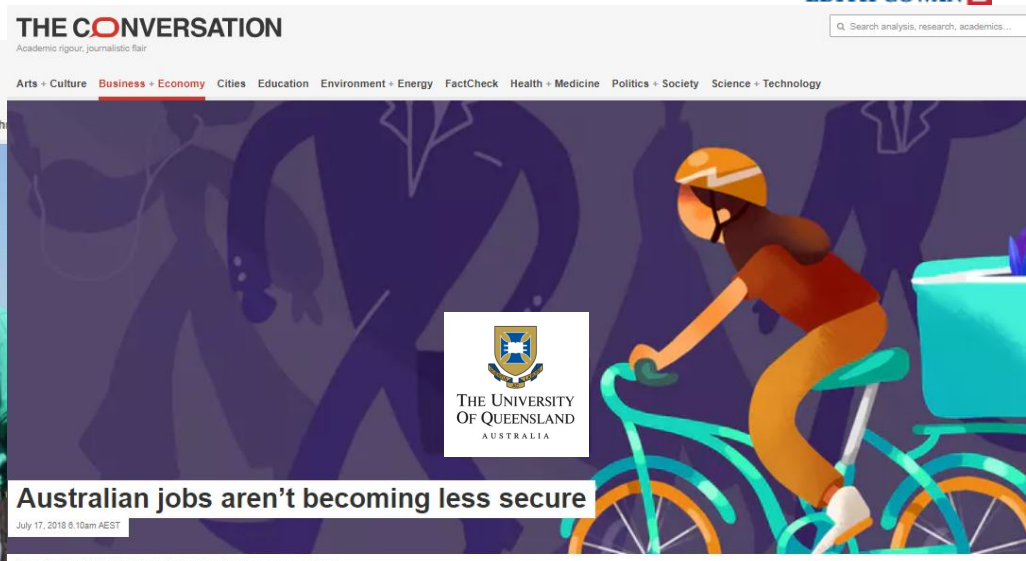
Precarious employment is increasing over time, and it still remains higher for women than men in Australia. But over the last nine years it has increased far more rapidly among men.

This is despite greater workforce participation and lower unemployment rates in Australia's labour market. The quality of jobs in Australia has been declining.

In a new Bankwest Curtin Economics Centre report, we develop a composite index of precarious employment using data from the Household Income and Labour Dynamics in Australia (HILDA) survey.

Read more: The costs of a casual job are now outweighing any pay benefits

The HILDA survey captures job attributes, labour force circumstances and other information about a large and representative sample of Australian workers. The index is based on 12 component indicators that capture different dimensions of precarious



Gig platforms don't have a large share of the labour market yet. Mavis Wong, CC BY-SA

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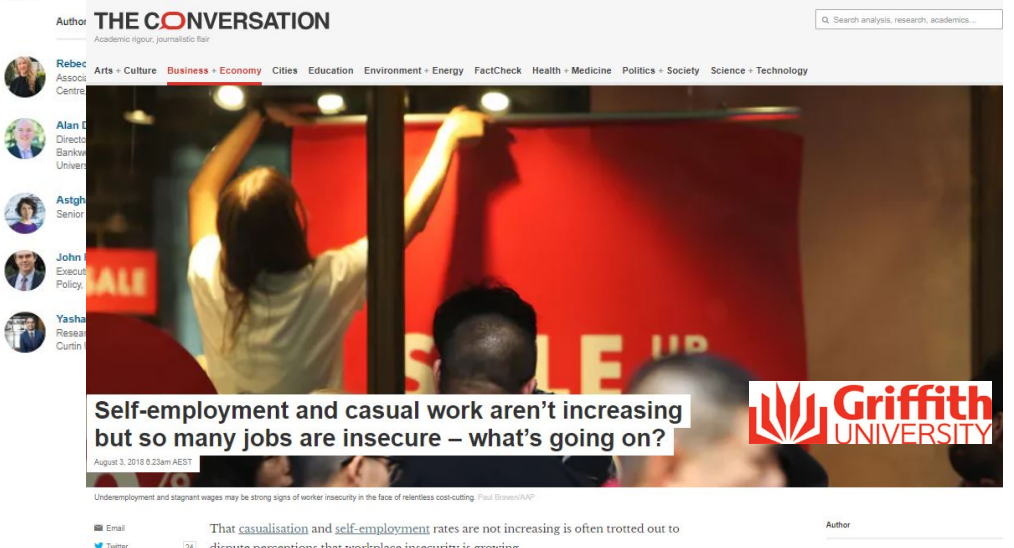
A common narrative nowadays is that standard, secure full-time work is a thing of the past thanks to increasing casual jobs, labour hire, temping and non-standard work contracts that side-step collective bargaining. The ACTU says insecure work has grown to "crisis levels". A Senate inquiry rehashed the same themes last year. Much of the academic literature is also toeing this line.

Author

Robert Sobyra
PhD Candidate, The University of Queensland

Disclosure statement



Underemployment and stagnant wages may be strong signs of worker insecurity in the face of relentless cost-cutting. Paul Braven/AAP

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Facebook 144

That casualisation and self-employment rates are not increasing is often trotted out to dispute perceptions that workplace insecurity is growing.

Author

David Peetz
Professor of Employment Relations, Centre for Work, Organisation and Wellbeing, Griffith University

Research Project: Industry 4.0 & the Impact on the VET sector

- **Project: The Fourth Industrial Revolution - The implications of technological disruption for Australian Vocational Education and Training (VET)**
- **RQ: 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?

Seet, P-S, Jones, J., Spoehr, J., Hordacre, A-L. 2018. *The Fourth Industrial Revolution – Implications of Technological Disruption for Australian VET.* NCVER, Adelaide, SA. (ISBN: 978-1-925717-20-4) https://www.ncver.edu.au/research-and-statistics/publications/all-publications/the-fourth-industrial-revolution-the-implications-of-technological-disruption-for-australian-vet

Main Findings of the Research

- **Reduced need for some jobs but main issue = changing the nature of existing jobs** and in doing so has **expanding the range of tasks**, such as problem-solving and collaboration, creating the need for additional skills and knowledge.
- 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**.
- **Specialist technology-related skills** are important from a range of engineering disciplines, as well as software development and computer programming
- **Importance of generic non-technical skills** and competencies to include team working, creativity and problem-solving to explore and deploy technologies effectively in workplaces.
- 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**.
  - Continual learning, Lifelong learning, Regular Upskilling, etc…
- Some employers reported difficulties in **finding public and/or private providers with the capacity to provide education and training in specific disruptive technologies.**

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

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**.

What can WA learn from the Research?

- 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.
- **3 alternative scenarios** of automation (Hirsch-Kreinsen, 2016) – don't focus on one
  - Technology-centred scenario (automation)
  - **Hybrid scenario**
  - **Specialisation scenario**

- The **Higher Ed, VET sector, Government and Employers need to work together** to support the updating and upgrading of the lifelong learning skills of 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.

Seizing Industry 4.0 Opportunities: A Case Study of University-Industry-Government Collaboration

- Start-up looking to gain a niche in an increasingly competitive space.
- New product development opportunity from cloud-mobile-sharing economy.
- ECU School of Business and Law collaborative research project with Jugglr
  - 2017/18: "*Transforming Underemployed Women Professionals to Mumpreneurs: Exploring Opportunities to Overcome Labour Market Failure and Unlocking Human Capital through Disruptive Innovation*"
  - Further support: City of Joondalup Innovation Fund.
    - https://www.joondalup.wa.gov.au/city-awards-latest-innovation-fund-grant?nocache=true
  - Submission to the Victorian Government's Inquiry into the On-Demand Economy
- 2018/19 collaboration with Wanneroo Business Association: *"Ready for the Age of Digital Disruption: Challenges and Opportunities for Outer Suburban SMEs"*

Thank you

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Janice Jones, John Spoehr, Ann-Louise Hordacre, Flinders University

Other sources of information:

- Full report on NCVER website (research funding body)
- Articles on The Conversation
  - Seet, P-S, Jones, J., Spoehr, J., Hordacre, A-L. 2019. Jobs are changing, and fast. Here's what the VET sector (and employers) need to do to keep up. The Conversation. 25 June 2019. https://theconversation.com/jobs-are-changing-and-fast-heres-what-the-vet-sector-and-employers-need-to-do-to-keep-up-118524
  - Seet P-S., Jones, J., 2019. The government keeps talking about revamping VET – but is it actually doing it? The Conversation. 30 May 2019. https://theconversation.com/the-government-keeps-talking-about-revamping-vet-but-is-it-actually-doing-it-117743
- Senate Select Committee on the Future of Work and Workers
  - https://www.aph.gov.au/DocumentStore.ashx?id=2ee99af1-9f11-43c7-9791-e2cb2b8f8278&subId=563771
  - http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22committees%2Fcommsen%2F9794d543-f5b2-4c0a-8a37-51ecb4459a75%2F0000%22
- Media commentary on the research
  - The Australian newspaper: https://www.theaustralian.com.au/higher-education/call-for-vet-unis-to-face-future-together/news-story/ad04458ea62b483a81d8809c0d82703c
  - The AFR: https://www.afr.com/news/policy/education/vocational-training-could-find-a-huge-market-if-india--if-it-can-get-its-act-together-20180810-h13tfm
- Social Media:
  - ECU School of Business and Law website and LinkedIn Site:
    - http://www.ecu.edu.au/schools/business-and-law/overview
    - http://www.ecu.edu.au/schools/business-and-law/research
    - https://www.linkedin.com/groups/13606165
  - ECU Centre for Work and Organisational Performance (CWOP): @CWOP_ECU; https://www.linkedin.com/groups/13586400
  - Pi-Shen Seet: @pishenseet

Call for VET, unis to face future together

TIM DODD
HIGHER EDUCATION EDITOR

More integration between higher education and vocational education is needed to develop the high-level skills workers will need to deal with automation, a report from the National Centre for Vocational Education Research says.

Titled The Fourth Industrial Revolution: the implications of technological disruption for Australian VET, the report said greater integration would help to build both the hard technical skills and the soft skills needed in the so-called fourth industrial revolution. However it noted that achieving this was difficult.

"While there have been calls for closer integration between the VET (vocational education and training) and university sectors, this may be more easily said than done," the report said.

The four authors — researchers Pi-Shen Seet of Edith Cowan University and Janice Jones, John Spoehr and Ann-Louise Hordacre of Flinders University — say in the report there is also a shortage of specialised trainers needed to train students in the skills needed for the fourth industrial revolution, which is based on artificial intelligence and automation technologies.

The first three industrial revolutions were based on steam, electricity and oil, and digital computers respectively. The fourth revolution is often abbreviated as Industry 4.0.

"No one at TAFEs, no one at universities is teaching the stuff that's needed to be known at the moment," one manager told the researchers. The manager said many lecturers at technical and further education colleges and universities were not across the most up-to-date information in their areas.

A number of managers in firms interviewed told researchers that trainers and teachers needed to do fast-track training "to acquire the necessary knowledge and understanding of Industry 4.0".

Another barrier was the system of "training packages" — the agreed curriculums for training young people in various industries — which were found to be too inflexible and unable to be changed fast enough to meet new needs in disruptive technologies.

The NCVER report said there could be a role for rapid "micro-credentialling" courses that could deliver more flexible, just-in-time education.

The Australian Newspaper 8 Aug 2018

completed their study units last year. This is 17 percentage points higher than the equivalent figure under the old VET FEE-HELP scheme in 2016.

Assistant Vocational Education and Skills Minister Karen Andrews said the government is achieving that aim".

Last year, 42,220 students received VET Student Loans and more than $200 million was loaned to pay tuition fees under the scheme.

TIM DODD

It found employers also had a strong need for people with soft skills such as creativity, teamwork, problem-solving and continuous learning, and these were "integral to the uptake and implementation of disruptive technologies".

"These are essential for preparing workers to be flexible and to cope with the rapid changes in the future workplace," the report said. It also noted soft skills were uniquely human, and not easily replicable by machine.

'No one at TAFEs, no one at universities is teaching the stuff that's needed to be known'

MANAGER IN SURVEY

It said that the new Industry 4.0 Industry Reference Committee announced this year by the Australian Industry and Skills Committee would help vocational educators shift attention to future-focused skills.

The committee's job is to work with industry to identify the competencies students will need in future, such as big data, automation, digital skills and cybersecurity.

The report also praised the AISC for working on a range of industries to move beyond a siloed approach to skills, and to develop cross-industry skill sets and qualifications.

However, the NCVER report found no evidence of fully automated production processes being introduced that would cause major job losses. Instead, it found workers operating alongside new disruptive technologies, such as 3D printing, and this was requiring them to acquire new, high-level skills.

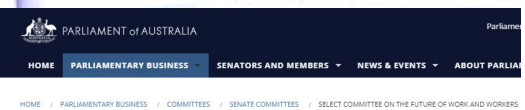
It said the picture was complex, with workers in some areas likely to be displaced.

The VET sector faced a "significant challenge", it said.

Another research paper issued this week, by Hugh Guthrie, at the University of Melbourne's LH Martin Institute, and Berwyn Clayton, of Victoria University, also called for VET reform, saying: "VET policymaking at present is in the hands of officials who lack contextual knowledge, especially of the VET system and how it actually works."

They said the sector suffered from too-fast policy changes that led to "incomplete implementation and change fatigue" and a "critical lack of effective policy analysis, program monitoring and evaluation".

The authors called for a comprehensive review of vocational education and training along the lines of the seminal Kangan review of the 1970s, and the creation of an agency similar to the Australian National Training Authority, which was closed in 2005.



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