4

Digitalisation and the jobs of the future

Mae's eventual job in *The Circle* was essentially to monetise the influence she had through her social media platform. We presently call this an 'influencer'.[1] It was a job that really did not exist a few decades ago. The closest thing may have been how sports stars and TV celebrities made large amounts of money by endorsements of products—they were a kind of 'influencer', but their main job was something else. Over years, technological changes had enabled the creation of this job.

We saw in Chapter 3 the potential role of technology, through both *Nineteen Eighty-Four* and *The Circle*. The authors of both books tried to imagine technologies of the future and how they would be used, but in neither case wrote beyond the realms of possibility. In all probability, the technologies seemed all too real in each of the three books featured in that chapter. Importantly, it was the social order that shaped how technology would affect people's lives.

Popular interest in the future of work, however, often centres around how technological change will affect the types of jobs we do. So let us look at that. In this chapter, we look at trends in employment and how they will be affected by two of the 'mega-drivers of change' mentioned earlier: technological change through digitalisation, and demographic change. On the supply side, we consider the 'ageing' and so-called 'feminisation' of

1 Though some prefer 'content creator'. Ben Bryant and Moya Lothian-McLean, 'How "Influencer" Became a Dirty Word'. *BBC*, 23 February 2019, www.bbc.co.uk/bbcthree/article/61d019b6-fd08-4da5-aaf8-b28faf17e616.

the workforce. We will see that demographic changes affecting workplaces include workforce ageing and growing female labour force participation. On the demand side, we look at the sorts of jobs that will be created and destroyed by technical change. We also consider the veracity of competing claims about the future numbers of jobs. Will over 40 per cent of present jobs not exist, as allegedly estimated in a study at Oxford University?[2] We look at the areas of growth and decline in the industries and occupations of employment, and the levels of skills, if any, that will be demanded. There are major industrial changes (such as the decline of manufacturing) and occupational changes (the shift to 'white collar' work, including professional employment). We also mention six 'disruptive technologies' identified by the International Labour Organization (ILO) as affecting the world of work. So, the demand side dominates this chapter. We finish with a discussion on the implications for trends in inequality and ethics.

External forces for change in the workplace

The ILO, in one of its publications, identified four major forces for change in the workplace: demographic change; technological change; globalisation; and climate change.[3] To these might be added another matter frequently raised by the ILO: changes in the employment relationship,[4] which we cover in Chapter 6.

We discussed globalisation in Chapter 2, and we will discuss climate change in Chapter 9. Demographic change refers to changes in the characteristics of workers themselves. Technological change may affect what employers produce (their industries), what employees do (their occupations), and the organisation of work including the employment relationship itself. So we will cover demographic changes first.

2 Carl Benedikt Frey and Michael A. Osborne, *The Future of Employment: How Susceptible Are Jobs to Computerisation?* (Oxford: Department of Engineering Science, University of Oxford, 2013).

3 International Labour Office, *Future of Work. Inception Report for the Global Commission on Work* (Geneva: ILO, 2017).

4 International Labour Office, *A Challenging Future for the Employment Relationship: Time for Affirmation of Alternatives?* Future of Work Centenary Initiative, Issue Note Series No. 3 (Geneva: ILO, 2017).

Demographic changes

On the supply side, there are two important forces to consider: an ageing and maybe a 'feminising' workforce.

An 'ageing' population

We are all getting older, of course (well, you are, anyway). But this term refers to the tendency for the workforce's share occupied by young workers to decline, while the share of older workers increases. The former phenomenon is due to gradually declining birth rates, and the latter phenomenon reflects a trend for workers to retire later (particularly since the mid-1990s) and for women workers, in particular, to return to the workforce in growing numbers after their children have gone to school, or left home. So the average 'age' of the workforce, arithmetically, increases.

This trend is expected to continue, across all developed nations, though it is less a phenomenon in Australia than in most other advanced developed nations (in no small part due to immigration and a higher birth rate).

This creates some dilemmas for policy-makers. For a long time, governments were encouraging early retirement, on the rationale that retiring early would create 'room' for younger people entering the workforce. Now they worry about the implications for public finances, and how the workforce would be able to pay for aged care without raising taxes (as if taxation levels were set at some constant, which rather ignores the great cross-national variations in tax rates).

A common response is to lift retirement ages. At a number of levels this makes sense. Fewer jobs are manual. But what about those workers who have spent their lives in manual jobs? Increasing life expectancy reflects falling deaths from disease and accidents in working-age people, but it does not make postponing retirement any easier for workers whose bodies are, for work-related purposes, worn out by the time they hit their mid-60s. Some have been in low paid jobs. This makes an argument for easier access to disability pensions, but the trend has been in the opposite direction, in order to reduce public spending. Those with low capacity are being asked to pay for demographic changes from which they have not benefited.

Governments urge employees to work longer, but have so far found no effective antidote to employer discrimination against older workers. Age discrimination in employment is widespread, evident in data on post-redundancy experiences, for example, and very difficult to detect.[5] The problem may not be an insufficient number of prime-age workers but an insufficient number of workers that employers are willing to accept.

Changing female participation

I have already mentioned that women in developed countries are returning to the workforce in growing numbers after their children have gone to school, or left home. So it is in the 35-and-above age groups that increases in women's labour force participation over the last two or three decades have been greatest. But women are also increasing their participation amongst some lower age groups as well, when children are younger (or not yet born).

Much, but not all, of this supply of female labour has been people looking for part-time hours, as the domestic division of labour means that it is women, rather than men, who are expected to provide primary care for children, including after-school hours.

But while the 'ageing' of the population is expected to continue, across all developed countries, the projections for female participation are less uniform. The ILO commented:

> the global gap in participation rates between women and men stood at more than 26 percentage points in 2016—a figure which is close to or exceeding 50 percentage points in Arab States, Southern Asia and Northern Africa. Looking ahead to 2030, based on current trends, there is little or no improvement expected in the gender gap at the global level.[6]

5 Mark Wooden, 'The Impact of Redundancy on Subsequent Labour Market Experience'. *Journal of Industrial Relations* 30, no. 1 (1988): 3–31; Linda Walley, Margaret Steinberg, and David Warner, *The Mature Age Labour Force*. Workforce Strategy Unit, Employment Taskforce, Monograph series No. 2 (Brisbane: Department of Employment, Training and Industrial Relations, May 1999); Chris Kossen and Cec Pedersen, 'Older Workers in Australia: The Myths, the Realities and the Battle over Workforce "Flexibility"'. *Journal of Management & Organization* 14 (2008): 73–84.

6 International Labour Organization, 'Gender Gap in Participation Rates Is Not Expected to Improve over the Coming 15 Years'. ILO, 2017, www.ilo.org/global/topics/future-of-work/trends/WCMS_545630/lang--en/index.htm.

Female labour force participation is high in very poor countries. It is lower in middle-income countries, and higher again in high-income countries.[7] A very stylised way of explaining this would be to say that, in very poor countries, most women work since household incomes are so low. As incomes rise, for example through industrialisation, women can leave the workforce and focus on childcare, and it may seem rational in a sense to do so as men typically receive higher pay (hence, for example, female labour force participation in China has been declining for at least two decades).[8] As national incomes rise, and institutions supporting women in the workforce improve (e.g. state-subsidised childcare or maternity leave entitlements), women re-enter the workforce and participation rises again.[9]

It is an overly simplistic story because there are very large divergences in female labour-force participation among countries with similar levels of economic development, reflecting such matters as the availability and acceptance of education for women (which reduces participation among the young, but increases it among older women by increasing incomes) and dominant norms about working women. Educational norms help us understand, for example, the very high gender gaps in labour participation in some of the regions mentioned above.

Industrial changes

Over the past four decades, manufacturing has been in relative decline in developed countries. Between 1970 and 2013, manufacturing jobs' share in total employment fell from 24.3 per cent to 11.9 per cent across the OECD.[10] The 'services' sector—a term used to describe anything that isn't primary (agriculture, forestry, fishing or mining) or secondary (manufacturing) industry, so it is not all that useful—has increased its share of employment.[11] Within the services sector, health, community and aged care has grown substantially and is now the largest employer. By 2030, 'healthcare and social assistance' is likely to be close to 15 per cent

7 Sher Verick, 'Female Labor Force Participation in Developing Countries'. *IZA World of Labor* 87 (2014): 1–10.

8 Statista, 'Female Labor Participation Rate in China from 2007 to 2017'. Statista, 2019, www.statista.com/statistics/252721/female-labor-force-participation-rate-in-china/.

9 Verick, 'Female Labor Force Participation'.

10 Organisation for Economic Co-operation and Development, *Knowledge Economies: Trends and Features*. OECD Science, Technology and Industry Scoreboard 2015 (Paris: OECD, 2015).

11 Ibid.

of Australian employment, and manufacturing, accounting for a quarter of the workforce in the 1960s, will be less than 5 per cent.[12] The trend may be less pronounced, but it will be in the same direction, in most industrialised countries.[13]

Occupational changes

There has been a long-term decline in 'blue collar' or 'manual' work, mirrored by an equivalent increase in 'white collar' or 'non-manual' work. For example, in Britain, the blue collar share of jobs fell from 62 per cent in 1961 to 41 per cent in 1991 and a mere 29 per cent in 2006.[14] This is despite the fact that some jobs classified as being in the 'services' sector are 'blue collar' jobs in construction or utilities. Among 'white collar' work, professional occupations have particularly grown, including medical professions such as doctors, nurses and associated health professionals.

The emphasis has been more on jobs requiring higher level or creative skills. So in 1996, Australian employment of photographers and, on the other hand, photographic designers and printers, were both around 8,000; by 2014 the former group was more like 12,000, the latter group almost disappeared. In 2001 there were almost 30,000 graphic designers and almost 30,000 printers and graphic press workers; by 2014 there were close to 50,000 of the first group and 20,000 of the second.

Between 2003 and 2012 the greatest increase in employment was in the jobs requiring the highest skill levels (employment in occupations with 'skill-level 1' grew by 38 per cent, and 'skill-level 2' grew by 32 per cent, compared to 10 per cent, 18 per cent and 6 per cent respectively amongst skill levels 3, 4 and 5).[15]

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12 Katherine Barnes and Peter Spearritt, eds, *Drivers of Change for the Australian Labour Market to 2030* (Canberra: Academy of the Social Sciences in Australia, 2014).

13 Even in Germany, the OECD's largest manufacturer, the share of manufacturing in employment fell from 33 per cent in 1970 to 18 per cent in 2013. Organisation for Economic Co-operation and Development, *Chapter 1. Knowledge Economies: Trends and Features*.

14 Learning and Skills Council, *Skills in England 2007 Volume 2: Research Report* (Coventry: LSC, 2007); Mike Savage, 'Individuality and Class: The Rise and Fall of the Gentlemanly Social Contract in Britain'. In *Social Contracts under Stress: The Middle Classes of America, Europe, and Japan at the Turn of the Century*, ed. Olivier Zunz, Leonard James Schoppa, and Nobuhiro Hiwatari (New York: Russell Sage, 2002): 47–65.

15 Kirsten Woyzbun, Susan Beitz, and Katherine Barnes, 'Industry Transformation'. In *Drivers of Change for the Australian Labour Market to 2030*, ed. Katherine Barnes and Peter Spearritt (Canberra: Academy of the Social Sciences in Australia, 2014), 17–34.

CSIRO researchers analysed employment patterns of occupations since the 1980s and found that jobs involving 'people skills' grew most rapidly, jobs working with machines or doing manual work declined the most in numbers, and knowledge and service occupations grew about average (though, within knowledge occupations, those involving the highest skills grew most rapidly, while those involving the lowest skills grew least rapidly).[16]

Global value chains

A major phenomenon, by which firms have incorporated changes in technology and management systems into their production structures, has been the growth of global value chains (also referred to as 'global supply chains' or even 'global value networks'). For example, Woyzbun, Beitz and Barnes showed the many countries involved in the construction of a Boeing 787 Dreamliner, including:

- the engines from Rolls-Royce in Derby, UK, and GE in Evendale, Ohio, USA
  - but the engine covers ('nacelles') from Goodrich in Chula Vista, California, USA
- the wing from several countries including:
  - the main part of the wing from Mitsubishi in Nagoya, Japan
  - the wing tips and flap support fairings from KAL-ASD in Busan, Korea
  - the leading edge from Spirit in Tulsa, Oklahoma, USA
  - the fixed trailing edge from Kawasaki in Nagoya, Japan
  - the moveable trailing edge from Boeing in Melbourne, Australia
  - the centre wing box from Fuji in Nagoya, Japan
- the fuselage also from several countries:
  - the forward fuselage from Spirit in Wichita, Kansas, USA
  - the mid-forward fuselage from Kawasaki in Nagoya, Japan
  - the centre fuselage from Alenia in Grottaglie, Italy

16 Stefan Hajkowicz et al., *Tomorrow's Digitally Enabled Workforce: Megatrends and Scenarios for Jobs and Employment in Australia over the Coming Twenty Years* (Brisbane: CSIRO, 2016).

  - the aft fuselage from Boeing in Charleston, South Carolina, USA and from KAL-ASD in Busan, Korea
  - the passenger doors from Latecoere in Toulouse, France
  - the cargo access doors from Saab in Linkoeping, Sweden
- as for the tail:
  - the horizontal stabiliser from Alenia in Foggia, Italy
  - the tail fin and tail cone from Boeing in Frederickson and Auburn, respectively, both in Washington, USA
- and when you land:
  - the main landing gear well from Kawasaki in Nagoya, Japan
  - the landing gear doors from Boeing in Winnipeg, Canada
  - the landing gear from Messier-Dowty in Gloucester, UK.[17]

In the manufacture of mobile phones and other digital devices, Apple only employs a small fraction of the more than 700,000 people who are part of its global value chain.[18]

Global value chains are the most efficient way for a major corporation to maximise profits. Especially when production is undertaken in less developed countries, they provide low costs while still enabling the corporations to maintain control over the production process but avoid accountability for poor behaviour (low wages, bad or hazardous working conditions) overseen by managers within that production process. It is thus both controversial and accepted as the normal way of doing things. We look again at global value chains (and the broader employment model of which it is a part, referred to as 'not there' employment) in Chapter 6.

Global ('transnational') corporations are, in turn, commonly owned by clusters of international financial institutions. A global corporation must have a formal headquarters in a physical location somewhere, and its managers and directors all have some geographical home, but chains of command and ownership rely less and less on geographic ties. Hence researchers increasingly talk of a transnational capitalist class[19] and of

17 Woyzbun, Beitz, and Barnes, 'Industry'.

18 International Labour Office, 'Changing Nature of Work in the 21st Century: Technology at Work' (Geneva: ILO, 2017).

19 William I. Robinson and Jerry Harris, 'Towards a Global Ruling Class? Globalisation and the Transnational Capitalist Class'. *Science and Society* 64, no. 1 (2000): 11; Georgina Murray and John Scott, *Financial Elites and Transnational Business: Who Rules the World?* (Cheltenham: Edward Elgar, 2012).

individual beneficiaries' minimal contributions to any state revenues, due to the use of tax havens to avoid what were once considered to be civic responsibilities.[20]

The future of employment growth

What are the jobs of the future? There are short-term trends to consider—for which the recent path is a reasonable guide—and there are longer-term trends, which are necessarily harder to pick and dependent on a range of technological, social and economic developments. So we look first at the short term, before considering new technology and what that might mean for the longer term.

Employment growth in the near future

A reasonably representative indication of industrialised countries generally might be found in the employment projections of Australia's Department of Jobs and Small Business. It projects employment growth five years ahead, based on fairly sophisticated extrapolations from the recent past and information at hand about likely developments, and in 2017 it projected that, by 2022, the fastest employment growth was expected to occur in the healthcare and social assistance industry (with 16 per cent total growth in employment) followed by professional, scientific and technical services (13 per cent), and education and training (12 per cent). Industries expected to show an absolute fall were electricity, gas, water and waste services (by 7 per cent); manufacturing (4 per cent); and agriculture, forestry and fishing (1 per cent). The biggest contribution to employment growth was also expected to come from the healthcare and social assistance industry, which was expected to add a bit over a quarter of net new jobs. Essentially, this reflects expectations that lots of people are going to get old over the next few years.

20 Anthony Van Fossen, 'Money Laundering, Global Financial Instability, and Tax Havens in the Pacific Islands'. *The Contemporary Pacific* 15, no. 2 (2003): 237–75; Oxfam Australia, *The Hidden Billions: How Tax Havens Impact Lives at Home and Abroad* (Oxfam, 2016); Javier Garcia-Bernardo et al., 'Uncovering Offshore Financial Centers: Conduits and Sinks in the Global Corporate Ownership Network'. *Scientific Reports* 7 (2017); Facundo Alvaredo et al., *World Inequality Report 2018* (World Inequality Lab/WID.world, 2018).

The *occupational* group with the largest growth rate was expected to be community and personal service workers (19 per cent), while the worst job prospects were for clerical and administrative workers (just 2 per cent growth). That said, these were averages only, and within each of these occupational groups there was lots of variation. For example, among professionals, the fastest growing profession at the more disaggregated level (audiologists and speech pathologists or therapists) had projected employment growth of 32.6 per cent, while at the other end the worst (surprisingly, ICT sales professionals) was projected to face an employment fall of 11 per cent. The fastest growing occupation at this level of disaggregation was aged and disabled carers (47 per cent), who would also provide the biggest contributions to projected employment growth, while other major contributions were expected to come from registered nurses, child carers and general sales assistants. At the other end of the scale, it looked like there could be a lot of displaced secretaries, farmers, accounting clerks, bookkeepers, checkout operators, technical sales representatives and people in several manufacturing occupations.

And what about skill levels? Generally speaking, in the past technological change has tended to have greater impacts on low-skilled than high-skilled jobs, but is that what is projected over the next five years? Those same Australian projections indicated that the fastest employment growth rate, and the greatest contribution to employment, was still expected to be made by the highest skill-level group (skill-level 1). The next highest growth rate is among skill-level 2. But, interestingly, skill-level 4 (the second lowest) is projected to have considerably faster growth than skill-level 3 (the middle skill-level, which was expected to be the worst of all five groups). The biggest factor in the expected growth of skill-level 4 is the growth in aged and disabled carers, which, in Australia, will be promoted by the National Disability Insurance Scheme but is really an integral feature of most industrialised countries' employment futures. So it is not a uniform picture. That said, there was tremendous variation between the occupations that make up each skill level. European data also suggests that employment growth will, on average, be strongest in the high-skilled occupations but that, as some jobs requiring high skills are at risk of being automated, highly educated workers might also face increased competition on the labour market.[21] In short, with some caveats,

21 Cornelia Suta, Luca Barbieri, and Mike May-Gillings, 'Future Employment and Automation'. *Quaderni Fondazione G. Brodolini: Studi e Ricerche* 61 (2018): 17–43.

future employment prospects were not so much a question of 'how skilled you are likely to be' but 'in what area you have (or you can obtain) skills'. The European target strategy target of 25 per cent of people 'engaging in learning throughout their lives by 2025' may be insufficient.[22] The variability of experiences over time also tells us that adaptability is going to be very important as well, perhaps more important than the specific area in which people have skills.

Recent developments in technology

Over the past half-century, several developments in technology have significantly affected the workplace. These include computer chips; word processing, spreadsheets and personal computing; communication technology (mobile phones); automation and robots; the internet; and barcodes and scanning. In recent years, there has been considerable excitement about the role of technology in the future of work, including whether or not this will lead to a net loss of jobs and, if so, by how many; and, to a lesser extent, what impact it will have on the way work is organised.

The ILO has identified six 'disruptive' technologies.[23] These are:

- the 'internet of things'—a network of physical objects that have an IP address and internet connectivity and communication;
- 'big data'—a massive volume of structured or unstructured data, sometimes derived from commercial or personal transactions to predict behaviour or drive complex algorithms for such functions as language translation;
- 'cloud computing'—a network of remote servers to store, manage and process data, used instead of local computers;
- robotics—goods- or service-producing computers that, mechanically, behave in some way like humans would; by 2018 an estimate is that there will be 1.3 million robots in factories (though few of those look remotely human);

22 Ibid., 40.

23 Kai Hsin Hung, 'Tech@Work: Top 6 Disruptive Technologies You Should Know'. ITCILO, International Labour Office, 25 July 2016.

- 3D printers—creating three-dimensional objects based on computer programs;
- machine learning—giving computers the ability to learn autonomously, without being explicitly programmed (creating what is known as artificial intelligence).

The last three of these in particular have the potential to make many jobs, perhaps even industries such as manufacturing, obsolete. The 'internet of things', 'big data' and 'cloud computing' will affect how we work, but robotics, 3D printing and machine learning will affect both how we do our work and how many jobs there will be. Some alarmist predictions have been made, including one discussed below that 47 per cent of US jobs would be rendered obsolete by technical change. Regardless of any exaggeration, artificial intelligence means that it is no longer just routine jobs that are threatened by new technology.

How many jobs in the longer term?

Each year many new jobs are created, while many others are destroyed as firms downsize or close. The figures you see in the news each month, about how many jobs were 'created' (or 'lost') in the economy, are just net figures, disguising some large gross movements in both directions.

Some jobs will be easy to replace with machines, once artificial intelligence (AI) is more developed. Some jobs, particularly many involving emotional labour or creativity, will be much harder to replace. There are two main estimates that have been made of the number of jobs that will be eliminated by new technologies, AI and automation. The first one, which received a lot of publicity, came from two Oxford researchers, Frey and Osborne,[24] and was published in 2013. It found that 'around 47 per cent of total US employment is in the high risk category'. Their method was essentially to get an expert panel to look at 70 occupations, assign them into the 'automatable' (their term) or 'not automatable' categories, look at the characteristics or tasks of those jobs and, using US data, estimate the probability of automation of the other 632 US occupations for which they could get data.

24 Frey and Osborne, *Future of Employment.*

The alternative view, put by three German researchers writing a study for the OECD[25] and published in 2016, looked at data about individual jobs, not whole occupations, and concluded that 'on average across the 21 OECD countries, 9 per cent of jobs are automatable', and the figure was the same for the US. In effect, they took as their starting point Frey and Osborne's estimates for occupations but then applied those data to what individual employees said about their own work in another survey.

My own view is that Frey and Osborne's very large numbers do not tell us anything about how many *jobs* are going to be displaced, because *occupation* is too broad a category. The OECD researchers are probably a little closer to the mark, but substantial gross job losses seem likely. Neither, however, really tells us about how much unemployment will be created by technological change, for two main reasons.

The first is that these estimates do not (and usually cannot) take account of the *cost* of new technology. New technology has meant a proliferation of automatic car washes, but many car washes are still labour-intensive, because those machines are very expensive, and often people are cheaper. A while ago I came across a cartoon featuring two nurses and a robot 'nurse': one human nurse turns to the other and says 'He's being returned to the supplier. It turns out that his running costs are higher than our wages'.[26] That is before even taking account of the capital costs of new technology. We have the technology for commercial supersonic aircraft that would take us to the other side of the world in less than half a day. It would push workers in many airlines out of a job. We have had it for half a century. We do not do it because it is just too expensive to do what we would need to do.

The second reason, why those studies do not tell us how much unemployment will be created by technological change, is that they do not attempt to take account of how many new jobs will be created. Suppose technological change means a robot can now produce a toaster for half the price of one made previously. Most of those people previously making toasters would not be employed any more—or at least when they leave they would not be replaced. But because the toaster is cheaper, we as consumers now have money to spend on something else, not just

25 Melanie Arntz, Terry Gregory, and Ulrich Zierahn, *The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis*. OECD Social, Employment and Migration Working Paper No. 189 (Paris: Organisation for Economic Co-operation and Development, 2016).
26 View the cartoon at agedcaresite.wordpress.com/2015/01/27/aged-care-terminators/.

a toaster, that we did not have before. This 'new consumption' effect in turn will create more jobs. It is a more important effect than that arising from the fact that some people will be used to make the new machines. New technology results in the loss of some (perhaps many) jobs, and their partial, perhaps complete, replacement with other jobs, the net effect being on average less repetitive work requiring more skill—that is, the liberation of many workers from 'drudgery'. New jobs are created largely because people have more money to spend on consumption and buy things they did not buy before.

That said, some newly created jobs (empirically, a minority) involve less skill than previously (so there is no 'liberation' there); and some workers are not employed in the new jobs—they lack the 'skills' or location necessary for such employment, creating what is called 'structural unemployment'. The net effects of all this on the number of jobs is a bit uncertain. In particular, it depends on who saves money as a result of technological change—a point I will come back to shortly.

Bursts of technological change since the beginning of the industrial revolution over two centuries ago are not what has not led, in itself, to mass unemployment and depression. We certainly have experienced periods of mass unemployment, but these were not due to technology; they were due to the cycles and crises of capitalism and the failures of government macroeconomic management.[27] Whether an economy ends up with 'full employment' after a period of technological change depends much more on whether the state can ensure adequate demand (including through fiscal and monetary policy, and through enabling the benefits from productivity improvements to feed into consumer demand) and on whether the state can ensure retraining and re-employment of structurally affected workers than it does on the rate of technological change. Periods of structural unemployment also tell us that governments need to be active in training and retraining displaced workers for future skills, because the market will not do it, left to itself.

It is common to think of the rate of technological change as being unusually high at the moment, and to suggest, by that logic, that the past pattern (of new jobs replacing old ones) would not be repeated. However, to quantify the effects of technological change you look at productivity

27 John Maynard Keynes, *The General Theory of Employment, Interest, and Money* (Macmillan: London, 1936); Ernest Mandel, *Late Capitalism* (London: New Left Books, 1972).

growth—and productivity growth in most OECD countries peaked in the postwar era of full employment. It has declined each decade since the 1970s—that is, the pace (or at least the effect on labour demand) of technological change has been in medium-term *decline*.[28]

There is not much point in predicting in great detail *what* we will spend our extra money on and so what jobs will be created. History is littered with unfulfilled predictions about future technologies and jobs; though I suspect we can be confident that projections that the biggest employment growth will be among health professionals, followed by carers and aides, and business, human resource and marketing professionals, are roughly on the mark.[29]

But still, many people are interested in the jobs likely to disappear, even if others will likely be created in their place. Structural unemployment will almost certainly occur, affecting individuals and regions. That is because the jobs that are lost will involve different skills to the jobs that are created, and the people who lose jobs may not have, or live in an area where they can obtain, the skills that are needed to occupy the new jobs that are created.[30] The more people lack, and cannot obtain, those skills, the fewer new jobs will be created, because inflation will start to increase at a lower level of economic activity and governments will be reluctant to allow the economy to expand at a rate that permits inflation to expand above some desirable level.

So the first big constraint on economies' ability to create new jobs in response to technology's destruction of other jobs will be where the public money goes—that is, the willingness and ability of governments to spend money on effective structural adjustment programs. These are programs that retrain people who lose, or never get, jobs as a result of new technology, and help establish new enterprises, often new industries, in regions where those people live. The problem is that one of the tenets of neo-liberalism has been to reduce public spending, a tenet that runs counter to this need for structural adjustment expenditure.

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28 Organisation for Economic Co-operation and Development, 'OECD Productivity Database' (spreadsheet) (Paris: OECD, 2006).
29 Department of Jobs and Small Business, '2018 Employment Projections'. Department of Jobs and Small Business, 2018, lmip.gov.au/default.aspx?LMIP/EmploymentProjections.
30 Sarah O'Connor, 'Robot Shock Threatens the Most Vulnerable Communities'. *Financial Times*, 19 September 2017.

A number of governments in industrialised countries have put resources into 'active labour market policies' that go part way in this direction. One of these was Denmark, from where the term 'flexicurity' emerged to describe programs that combined 'flexibility' (for employers—it was easy to lay off workers) and 'security' (i.e. displaced workers had easy access to income support and retraining programs), an approach that earned the enthusiastic support of the OECD. But, over time, there was more emphasis placed on the 'flexi' part, and spending on those programs that promoted 'security' was cut back. Now the term 'flexicurity' is associated in many minds with the promotion of greater flexibility and *in*security. There are many examples of creative approaches that have been taken in the past to adjust to the structural loss of jobs,[31] but it will take a radical change in approach by many governments to adequately respond to the digital changes that lie ahead.

The second big constraint on economies' ability to create new jobs in response to technology's destruction of other jobs will be where the private money goes—that is, who saves money as a result of technological change. For much of the postwar period in the twentieth century, the gains from productivity growth were fairly evenly shared between capital and labour, so no major change in the distribution of income happened. In recent years, though, as a result of the changing balance of power, the gains from productivity growth—that is, the gains from new technology—have been absorbed mostly by capital, by high-income earners. This has been most evident in the USA, where since the 1980s productivity has grown substantially, but real median wages have been stagnant, so profits have soared and income has been redistributed to the wealthy: most of the increase in inequality has been due to a rising share of the top 0.1 per cent.[32]

That rather fortunate scenario I painted earlier, about what happens when a robot starts making toasters, depends on what happens to the price of the toaster after the robot has made it. If the full benefit of that productivity gain is passed on as lower prices, then all those savings will be available to be recycled in continuing demand. Alternatively, if wages for the remaining toaster workers go up by a significant amount, then again maybe all those productivity gains can be recycled in continuing demand.

31 John Buchanan et al., *Facing Retrenchments: Strategies and Alternatives for Enterprises* (Canberra: Department of Education, Employment and Training/AGPS, 1992).
32 Joseph E. Stiglitz, 'A Rigged Economy'. *Scientific American*, 1 November 2018.

But what happens if the corporation increases its share of income as a result of this change? Prices might go down, but not all the way; wages might even go up a bit, but not enough to account for all the productivity gain; and the capitalist then pockets the rest. Maybe it will be reinvested, or maybe paid out as dividends. If the latter, the new demand might not be enough to offset the loss of jobs.

The problem for job creation is that the wealthy are less likely than lower income earners to spend their money in a way that will create jobs—they have what economists call a considerably lower marginal propensity to consume. They are more likely to save additional money they receive by putting it into financial assets, perhaps as savings in a Cayman Islands account, or status goods such as artworks,[33] of which the increase in value leads to no new jobs being created. By contrast, lower income earners are more likely to spend additional money on consumption items, the production of which leads to other people being employed. In the extreme case, if all the income generated by new technology were to be spent on artworks, then almost no jobs would be created to offset the gross loss of jobs. In reality, not all money flowing to the rich is lost in this way—some 'conspicuous consumption' creates some jobs—but if the benefits of digital change flow much more to the rich, then insufficient jobs will be created to offset those lost by new digital technology. When Citigroup economists sought to explain the growth of income inequality in favour of the group they called the 'plutonomists' or the 'uber-rich', the first of the six drivers they listed was 'an ongoing technology/biotechnology revolution'.[34] Their emphasis, unfortunately, was on the benefits to investors of buying shares in the companies that produced conspicuous-consumption goods.

A solution sometimes offered to this conundrum is to create a universal basic income (UBI). This is discussed more in Chapter 11; here we just observe that it would not stop the high growth in incomes and expenditures of the wealthy alluded to by the Citibank economists, though it may have other effects.

33 Thorstein Veblen, *The Theory of the Leisure Class: An Economic Study of Institutions.* (London: George Allen & Unwin, 1925; repr., 1970).

34 Ajay Kapur, Niall Macleod, and Narendra Singh, 'The Plutonomy Symposium—Rising Tides Lifting Yachts'. Citigroup Equity Strategy Industry Note (Citigroup Capital Markets, 29 September 2006), 7; Ajay Kapur, Niall Macleod, and Narendra Singh, 'Plutonomy—Buying Luxury, Explaining Global Imbalances. Citigroup Equity Strategy Industry Note (Citigroup Capital Markets, 16 October 2005), 9.

Much of the debate about the number of jobs displaced by new technology misses what else we could be focused on, particularly when examining work. Technological change has often been used to increase managerial or owner control (e.g. through barcodes, computer timing in call centres or apps in the 'gig economy'). This has often also enabled management to increase its control over the timing of labour—and more casual or labour hire employment—but there is little new, historically, about this. It harks back to the way labour was used, including through piece rates and contract labour, in the early parts of the industrial revolution or even in the nineteenth century.[35] And some technologies may have reverse effects (e.g. social media may have facilitated collective action).

Technological change in itself is neither malevolent nor benign. What matters is the social context within which it exists and the use to which it is put. The application of Einstein's theories of special and general relativity led to many lives being saved through new medical diagnostic and treatment procedures, but hundreds of thousands dying in Japan. The geospatial tracking that this theory made possible also makes it easier for us to find our way to the location of bookstores, but easier for trucking companies to monitor and control their workers—though also easier for the European Commission to enforce safe driving practices by truck drivers. Computers have made aspects of the lives of academics like me better, in as much as they enable research that could not be done in the past, but they have also led to surveillance and work intensification for workers in many industries like warehousing, call centres and even higher education. So the issues about technology and the future of work are more about the implications for power, control and equality or inequality. We will look at this issue in more detail in chapters to come. But first, we look more closely at the jobs that indeed might be under threat.

Which jobs?

The best publicly available data on jobs at risk from technological change come from the Frey and Osborne (2013) study mentioned earlier. So Table 4.1 lists the expected 'automatability' of occupations, using the US occupational classification system,[36] for the 20 least susceptible and (below them) the 20 most susceptible to automation among those

35 Simon Deakin, *The Comparative Evolution of the Employment Relationship*. Centre for Business Research, Working Paper No. 317 (Cambridge, UK: University of Cambridge, December 2005).
36 This classification system is not the same as that used in Australia.

300 occupations large enough to have their size estimated by gender in the US regular common population survey. It also shows the estimated size of employment of that occupation, based on data from the US Current Population Survey (CPS).[37]

Table 4.1: Risk of automation, US occupations, ranked by probability of automation

	Employment ('000)	Risk of automation
Low risk		
First-line supervisors of mechanics, installers and repairers	253	0.3%
Occupational therapists	122	0.4%
Lodging managers	156	0.4%
Dieticians and nutritionists	114	0.4%
Physicians and surgeons	1,079	0.4%
Psychologists	187	0.4%
Elementary and middle-school teachers	3,268	0.4%
Dentists	159	0.4%
First-line supervisors of police and detectives	95	0.4%
Medical scientists	161	0.5%
Counsellors	853	0.5%
Human resources managers	327	0.6%
Recreation and fitness workers	480	0.6%
Training and development managers	63	0.6%
Speech/language pathologists	141	0.6%
Computer systems analysts	554	0.7%
Social and community service managers	390	0.7%
Medical and health services managers	671	0.7%
Preschool and kindergarten teachers	712	0.7%
Secondary school teachers	1,039	0.8%
High risk		
File clerks	182	97%
Payroll and timekeeping clerks	129	97%
Counter and rental clerks	109	97%
Crushing, grinding, polishing, mixing and blending workers	72	97%

37 Bureau of Labor Statistics, CPS Tables, Table 11: Employed persons by detailed occupation, sex, race, and Hispanic or Latino ethnicity (Washington DC: BLS, 2019).

	Employment ('000)	Risk of automation
Credit authorisers, checkers and clerks	55	97%
Driver/sales workers and truck drivers	3,506	98%
Bookkeeping, accounting and auditing clerks	1,089	98%
Inspectors, testers, sorters, samplers and weighers	793	98%
Shipping, receiving and traffic clerks	623	98%
Claims adjusters, appraisers, examiners and investigators	350	98%
Tellers	306	98%
Packaging and filling machine operators and tenders	292	98%
Insurance claims and policy processing clerks	237	98%
Parts salespersons	130	98%
Order clerks	107	98%
Models, demonstrators and product promoters	61	98%
Data entry keyers	267	99%
Tax preparers	107	99%
Insurance underwriters	104	99%
Telemarketers	58	99%

Source: Frey and Osborne (2013) and US CPS Table 11.

In brief, it shows that several health-related professions, some types of managers or supervisors and even HR managers, appear pretty immune from replacement by machines. On the other hand, telemarketers, insurance underwriters, tax preparers and data entry keyers look, on this method, pretty doomed.

Despite the size threshold, the list contains many small occupations. So if we want to work out what sorts of workers are most likely to need to take-up resources for retraining, we could consider the data another way. Table 4.2 does that, by linking the danger of automatability to CPS employment estimates. The last column of Table 4.2 multiplies those numbers together, to give the expected 'employment risk' of an occupation, which can be thought of as the statistically expected number of people in an occupation displaced by technology, following the methodology of Frey and Osborne. The important thing is not the absolute value of the 'employment risk' since, as I mentioned, I think Frey and Osborne have overestimated the probability of automation. Rather, it is more useful to approach the last column in the table as indicating something about the *relative* numbers of workers at risk in an occupation. Even then, we should be very cautious in interpreting these numbers, as they fail to account for any differences in the costs of automation between occupations. So it is a rough guide, at best. Moreover, the risk of automation takes no account of the likely growth or decline in employment in a particular occupation due to other demand-related factors operating in product markets, especially the changing consumer behaviour as more consumption is freed by cheaper goods arising from new technology—an effect that is almost impossible to try to estimate with any certainty for all but a very short period ahead.

Table 4.2: Risk of automation, US occupations, ranked by size of employment risk

	Employment ('000)	Risk of being automated	Expected 'employment risk'
Driver/sales workers and truck drivers	3,506	0.98	3,436
Cashiers	3,253	0.97	3,155
Retail salespersons	3,235	0.92	2,976
Secretaries and administrative assistants	2,769	0.96	2,658
Waiters and waitresses	2,016	0.94	1,895
Cooks	2,079	0.83	1,726
Construction labourers	1,946	0.88	1,712
Accountants and auditors	1,804	0.94	1,696
Labourers and freight, stock and material movers, by hand	1,930	0.85	1,641
Janitors and building cleaners	2,307	0.66	1,523
Customer service representatives	2,494	0.55	1,372
Office clerks, general	1,271	0.96	1,220
Receptionists and information clerks	1,267	0.96	1,216
Managers, all other	4,398	0.25	1,100
Sales representatives, wholesale and manufacturing	1,264	0.85	1,074
Bookkeeping, accounting and auditing clerks	1,089	0.98	1,067
Maids and housekeeping cleaners	1,527	0.69	1,054
Personal care aides	1,365	0.74	1,010
Stock clerks and order fillers	1,525	0.64	976
Carpenters	1,351	0.72	973

Source: Calculated from Frey and Osborne (2013) and US CPS Table 11. Column 4 is column 2 multiplied by column 3.

Still, it is noteworthy that drivers (including truck drivers) are at the top of the list, due both to the large number in the occupation and the high risk of automation, followed by cashiers, retail salespersons, secretaries and administrative assistants, and then waiters and cooks.

What does this all mean for the future of jobs and careers?

There are a couple of ways that this sort of information may be used by people to predict the future. One is to extrapolate from existing trends. The second is to use your imagination.

There is a logic to the first. What can we know about other than what we know about? And for short to medium term trends, it's not a bad way to go. In effect, that is what government bureaucrats do in making projections, often in a rather sophisticated way and taking a little account of things that may make them think the current direction may be disrupted in some way. But even this can be difficult. Circumstances can change rapidly. For example, Ibis World in 2015 forecast 9 per cent growth in employment in black coal over the period from 2015–16 to 2020–21. By April 2016, Ibis World had revised its 2020–21 employment forecast downwards by 5.5 per cent, to growth of just 2.8 per cent.[38] Around this time, forecasts by the Australian Department of Employment were for a 20 per cent decline in employment in the coal industry by 2020.[39] Two years later and the five-year forecast by that department was for a decline of just 7.6 per cent. While the long-term prospects for coal mining are pretty clear (i.e. there aren't any), in the short to medium term they are very volatile, dependent in no small part on coal prices and on who does the numbers.

The further you look ahead, the less useful the present is as a guide to the future. This is especially the case in employment because technology is hard to predict and changing consumption patterns are even harder to predict. Some factors are evidently important, such as the ageing population and the increasing demands that will be put onto care workers.

38 IBIS World, 'Competitive Landscape'. Australia Industry Reports: Black Coal Mining, 2015; IBIS World, *Black Coal Mining in Australia*. IBISWorld Industry Report B0601 (Melbourne: IBIS World, 2016).

39 Department of Employment, 'Employment Projections', Canberra, lmip.gov.au/default.aspx?LMIP/EmploymentProjections.

In the short to medium term, it is very clear this will be a major area of growth. But in the long term? Robots are being developed to provide care in various forms for older people. Will people want these? Will they be economic? Will models of funding encourage or discourage providers from deploying them?

On the other hand, what about jobs in new technology—like computer designers and programmers? If technological change is going to be so rapid and important, would not that be the place to be? Maybe, but remember that ICT sales professionals had one of the greatest employment declines projected to 2022. Computer systems analysts may be hard to replace with machines, but some people argue that computer programming will eventually be done by other computers, once AI becomes more advanced. Computer industries and occupations are likely to become strategically important, but they need not be numerically important to do that. It is probably true to say that caring occupations will be very important in the long term, but *how* important is harder to estimate.

One of the major projects looking at the future of employment has been undertaken by Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) which, although specifically about that country, had implications for many other developed countries.[40] Going more on imagination than extrapolating trends in numbers, CSIRO speculated about six new jobs that may emerge, which they described as:

- bigger big-data analysts;
- complex decision support analysts (reflecting a move from 'big data' to 'big decisions' and 'an explosion of choice');
- remote-controlled vehicle operators (for drones, trucks, boats, etc.);
- customer experience officers (for mostly virtual shoppers);
- personalised preventative-health helpers (like personal trainers but in preventative health);
- online chaperones (in cybersecurity, management of online identities, responding to online bullying etc.).[41]

40 Hajkowicz et al., *Tomorrow's Digitally Enabled Workforce*.
41 Ibid., 76–82.

Interestingly, despite it being a scientific organisation, the CSIRO's report did not overly emphasise the growth of work related to scientific, technological, engineering or mathematical (STEM) fields in the future. While arguing that STEM skills would 'certainly be in demand', the report asserted that:

> our aging population means that the healthcare and aged care sectors will be the largest employers and thus most workers will need some hybrid of technical, business, creative and interpersonal skills. Although development of 'soft' skills in students is on the agenda of some tertiary education providers today, development and integration of specific programs in collaboration with employers might still be needed to ensure graduates are prepared for future workplace needs.[42]

A lot of scary or at least overblown stories are written about future jobs, with authors sometimes breathlessly exclaiming that 50 per cent of jobs studied for at university will disappear by some date (I have not been able to track down the original source, but if it is the Frey and Osborne research it is a misrepresentation of their findings) or that the top in-demand jobs now did not exist in the early 2000s (Really? No aged care workers?). Still, when you peel away the overblown rhetoric, there are sometimes useful indications, at least on the *type* of skills that will be in demand (not the specific skills themselves) and the implications these have for educational curricula and what some call 'employability'. These appear likely to be skills (or perhaps better expressed, *competencies*) relating to creativity, problem-solving, collaboration, cooperation, resilience, communication, complex reasoning, social interaction and emotional intelligence. They include empathy-related competencies such as compassion, tolerance, intercultural understanding, pro-social behaviour and even social responsibility.[43] Some of these are what universities used to call 'critical thinking', but there are also many social skills as well on that list. While ICT skills are likely to be important, they are unlikely to be sufficient on their own.

One other point about education is worth making. Education serves multiple purposes. It serves as a creator of skills and knowledge (human capital). It also serves, though, as a signalling device for employers.[44]

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42 Ibid., 88.

43 Phil Lambert, 'The Future of Work and Skills'. *Professional Educator* 17, no. 2–3 (2017): 15–17; Hajkowicz et al., *Tomorrow's Digitally Enabled Workforce*.

44 Luisa Rosti, Chikara Yamaguchi, and Carolina Castagnetti, 'Educational Performance as Signalling Device: Evidence from Italy'. *Economics Bulletin* 9, no. 4 (2005): 1–7.

There are many jobs people obtain for which their university education has not really provided prerequisite knowledge; they learn on the job how to do it or attend short, tailored courses. But the holding of a university degree signals to the employer that the successful applicant is capable of learning and (if highly credentialed) is more capable or suitable than other applicants.[45] In India, for example, a degree is a standard requirement for a call centre worker, not because the work requires a degree, but because of what possession of a degree signals.

Employers might raise or lower their demands of applicants, depending on how tight or loose the labour market is: one year they might demand a postgraduate qualification for a job, the next year (when labour is in shorter supply) they might be happy with an undergraduate degree. All the while this job might not really require a degree, just someone who is capable of learning how to do it. This process is called *credentialism* and, as the proportion of people in the workforce with degrees increases, is likely to lead over time to the bars on jobs being raised incrementally higher. So even if middle-skill jobs are in declining demand, the credentials required to get a job at that or even lower levels might increase over time. In that sense, choosing exactly the right field for a degree may be less important than simply doing one. As complexity of work increases and skill demands rise, employers will demand a more educated workforce (and continue to complain that it is not 'work ready') regardless of the desirability or ability of any education system to anticipate the skill needs of the future.[46]

Technological change, inequality and ethics

How has past and current technological change related to inequality? In the long run, new technology leads to higher living standards via higher incomes, which can be fought over by capital and labour. To what extent wage increases have occurred has depended on the relative bargaining power of labour and capital, which was approximately balanced in the immediate postwar era (in that the benefits of productivity growth were roughly evenly shared between labour and capital in that period). More

45 This point is also made with regard to trade qualifications by Phillip Toner, 'Long Run Shifts in the Industry and Workforce Structure of the Australian Construction Industry: Implications for a Sustainable Labour Supply'. Paper presented at Reworking Work: AIRAANZ 2005, Sydney, 503–9.
46 See also John Quiggin, 'In Praise of Credentialism'. *Inside Story*, 27 February 2017.

recently, the low rate of wages growth,[47] despite a fairly average rate of productivity growth, suggests that the balance of power has favoured capital since the 1980s. This is most obviously the case in the USA, where real median wages have been virtually frozen since the mid-1980s,[48] but is true to a lesser extent in many OECD countries, which have seen a decline in the labour share of national income.[49] Hence the rise of what is often called 'neo-liberalism' has been associated with a decoupling of wages and productivity.[50]

So, *if* the rate of technological change accelerates, then there could be more opportunities to depress wages, because there will be more opportunities to replace existing workers with machines and low bargaining power for workers in seeking to capture the productivity gains from that technology. Moreover, if capital captures most of the gains from job-displacing technology and spends it on conspicuous consumption goods or 'saves' it, maybe in an offshore tax haven,[51] then most likely insufficient new jobs will be created to offset job losses. If the state is unwilling (perhaps under pressure from capital) to devote the resources necessary to respond to the geographic and occupational structural issues, then structural unemployment will likely rise. However, technological change itself does not drive widening (or narrowing) inequality. Technological change has been going on for over two centuries.[52] There seems little new about it and, as shown in the productivity data, there has been no acceleration of it since the 1980s. If now the benefits of technological change are being disproportionately distributed to capital, we need to consider why that is happening and what has changed in recent decades.

47 Jim Stanford, 'The Declining Labour Share in Australia: Definition, Measurement, and International Comparisons'. *Journal of Australian Political Economy* 81 (2018): 11–32.

48 Frank J. Lysy, 'Why Wages Have Stagnated While GDP Has Grown: The Proximate Factors'. An Economic Sense, 13 February 2015, aneconomicsense.org/2015/02/13/why-wages-have-stagnated-while-gdp-has-grown-the-proximate-factors/.

49 Luci Ellis and Kathryn Smith, *The Global Upward Trend in the Profit Share*. BIS Working Paper No. 231 (Basel: Bank for International Settlements, July 2007); Damien Cahill, *The End of Laissez Faire? On the Durability of Embedded Neoliberalism* (Cheltenham: Edward Elgar, 2014).

50 Matt Cowgill, *A Shrinking Slice of the Pie* (Melbourne: Australian Council of Trade Unions, March 2013); Joe Isaac, 'Why Are Australian Wages Lagging and What Can Be Done About It?'. *Australian Economic Review* 51, no. 2 (2018): 175–90.

51 Facundo Alvaredo et al., *World Inequality Report 2018* (World Inequality Lab/WID.world, 2018); Thomas Piketty, 'Panama Papers: Act Now. Don't Wait for Another Crisis'. *Guardian*, 10 April 2016.

52 For example, Ruth Schwartz Cowan, *A Social History of American Technology* (Oxford: Oxford University Press, 1997); Joel Mokyr, 'Long-Term Economic Growth and the History of Technology'. In *Handbook of Economic Growth*, ed. Philippe Aghion and Steven N. Durlauf (Amsterdam: Elsevier, 2005), 1113–80.

It does not follow, though, that technology plays no role. Probably the way in which this issue has been highlighted most has been through the emergence of the so-called 'gig economy'. It refers to the use of technological platforms, created by companies like Uber, Airtasker, Deliveroo and so on, to arrange for the hiring of workers to do one-off tasks or, as they have been called for ages in the music industry, 'gigs'. Ostensibly these jobs are mostly performed not by employees but by independent contractors. By doing this, these organisations are able to pay these workers less than their entitlements as employees. But here the technology enables a particular form of work organisation to be reinforced. We will look at this in more detail in Chapter 6.

Technology and ethics

The preceding discussion raises many ethical issues. Should technological advances be permitted or encouraged if they lead to people losing jobs, even if the rest of society benefits through higher living standards? What obligations does society have to people who are displaced, and how much should it contribute to their retraining or welfare?

The ethical implications for work itself are wider. Computers enable the use of complex algorithms to facilitate decisions, on matters ranging from identifying the best person for the job or a promotion or a position in an educational institution, to the best performer in the job, to who should be targeted for counselling or dismissal. Yet algorithms are not neutral or unbiased: there are many examples of discrimination being unexpectedly built in to decision-making processes through the use of algorithms, as documented in Cathy O'Neill's aptly named book *Weapons of Math Destruction*.[53]

AI utilises the most complex algorithms—algorithms that 'learn' through experience and so change their behaviour. Universities are trialling an AI bot (at Griffith University it is called 'Sam') to deal with student queries. As it has more interactions with students, it will learn how to deal with more and more complex issues without the need to refer them on to a human. The more complex the algorithm, the harder it is to identify a source of discrimination, or even to identify its existence. Sometimes discrimination becomes too obvious. 'Tay', Microsoft's chatbot, had to be

53 Cathy O'Neill, *Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy* (New York: Crown Publishing Group, 2016).

shut down within a day after it started volunteering racist rants that it had 'learned' from other Twitter users. There were some major ethical issues there.[54] While Tay's adventure off the rails amused some, it demonstrated the potential damage that could arise when AI has significant control over something but lacks ethical guidance. More concerning still may be AI tools in the hands of individuals or organisations actively seeking to enrich themselves in ways that have little concern for the rights or privacy of individual workers, consumers or citizens.

Accordingly, some have sought to promote international standards on robotics and AI, for example through an international code of ethics. In 2010 a group of the world's leading AI and robotics researchers drafted a set of 'Principles of robotics: Regulating robots in the real world'.[55] It was more wide-ranging than Isaac Asimov's three fictional 'laws for robots',[56] but driven by the same need to find a resolution to the complex ethical issues arising from AI. There have been special editions of journals looking at the question of how to build ethical design into AI systems: if you cannot be certain of being able to push the 'big red button' (the switch that enables you to turn off an AI device before it becomes maliciously self-aware), then is it possible to design ethical programming into an integrated part of the AI system, without the system knowing about it?[57] Most recently, there has been work done by the Institute of Electrical and Electronics Engineers (IEEE) and the IEEE Standards Association, working towards an ISO standard that would incorporate ethical principles in the design of AI. But how would that work? How could it be made foolproof? How could ordinary citizens be given the capability to control the use by others of their personal information, histories or behaviours? And what would happen if not everyone incorporated such design principles into their AI systems? What of the 'biohackers' who eschew hospitals, universities and regulatory institutions, using backyard workshops and linking with

54 Elle Hunt, 'Tay, Microsoft's AI Chatbot, Gets a Crash Course in Racism from Twitter'. *Guardian*, 24 March 2016, www.theguardian.com/technology/2016/mar/24/tay-microsofts-ai-chatbot-gets-a-crash-course-in-racism-from-twitter.

55 It was initially released in 2011 then published as a journal piece as Margaret Boden et al., 'Principles of Robotics: Regulating Robots in the Real World'. *Connection Science* 29, no. 2 (2017): 124–29.

56 Isaac Asimov, *I, Robot* (New York: Gnome Press, 1950).

57 Thomas Arnold and Matthais Scheutz, 'The "Big Red Button" Is Too Late: An Alternative Model for the Ethical Evaluation of AI Systems'. *Ethics and Information Technology* 20, no. 1 (2018): 59–69; Iyad Rahwan, 'Society-in-the-Loop: Programming the Algorithmic Social Contract'. *Ethics and Information Technology* 20, no. 1 (2018): 5–14; Peter Vamplew et al., 'Human-Aligned Artificial Intelligence Is a Multiobjective Problem'. *Ethics and Information Technology* 20, no. 1 (2018): 27–40.

body piercers to implant forms of computer technology into their own bodies?[58] What of rogue states or corporations who failed to follow the ethical guidelines? As Moshe Vardi pointed out, the dramatic reductions in automobile deaths over the last century arose from regulation, not ethical design of cars. Regulation should be determined by ethics, but not vacate the field in favour of it.[59] But how would such regulation operate? Vardi proposes, as first steps, some simple regulations promoting things like transparency of code,[60] but there are big issues that require a lot of thought and action.

And so there is also the question of the ethics of human interaction with AI. Suppose the key ethical issues are not in how the algorithms are designed but in how humans use them—especially when, as seems inevitable, digital technology is integrated with human biology.[61] We will not just have to consider AI machines that can be programmed to kill, or with the side-effect of killing, but also humans who, equipped with AI, can do those things.

These are real 'sliding doors' issues. The life-and-death matter of machines that can kill is just an extreme example of the outcomes of choices to be made. In the face of these, the choices we make about what courses to study or what careers to pursue might seem minor—but they are not. Organisations face real ethical issues that must be addressed. What of the use of predictive technology that can anticipate whether a person will 'work out' in a job? Is it ethical to hire or not hire someone on the basis of such predictions, bearing in mind that many such predictions may contain gender- or race-based biases?[62] What if that technology can 'learn'

58 Lauren M. Britton and Bryan Semaan, 'Manifesting the Cyborg Via Techno Body Modification: From Human–Computer Interaction to Integration'. Paper presented at CHI 2017—Proceedings of the 2017 ACM SIGCHI Conference on Human Factors in Computing Systems, Denver, 2017, 2499–510.

59 Moshe Y. Vardi, 'Cars Are Regulated for Safety—Why Not Information Technology?'. *The Conversation*, 22 March 2019, theconversation.com/cars-are-regulated-for-safety-why-not-information-technology-111415.

60 Ibid.

61 Guardian, 'Elon Musk Wants to Connect Brains to Computers with New Company'. *Guardian*, 28 March 2017; Antonio Regalado, 'With Neuralink, Elon Musk Promises Human-to-Human Telepathy. Don't Believe It'. *MIT Technology Review*, 22 April 2017. See also Annalee Newitz, 'Scientists Just Invented the Neural Lace'. *Gizmodo*, 17 June 2015, www.gizmodo.com.au/2015/06/scientists-just-invented-the-neural-lace/. Jia Liu et al., 'Syringe-Injectable Electronics'. *Nature Nanotechnology* 10 (2015): 629–36; Bryan Johnson, 'Kernel's Quest to Enhance Human Intelligence'. *Medium*, 20 October 2016. medium.com/@bryan_johnson/kernels-quest-to-enhance-human-intelligence-7da5e16fa16c.

62 O'Neill, *Weapons of Math Destruction*.

as a person spends more time at work (as it will), and the employee does something that changes the prediction from 'will work out' to 'will not work out'? Is it ethical to fire them? What if that prediction is based on a new expression of social or political views that are out of step with those of the management? If corporations won't make ethical decisions, who should, and how? In the next chapter, we will see how some of these issues for management have been, and perhaps could be, manifest.

This text is taken from *The Realities and Futures of Work*, by David Peetz, published 2019 by ANU Press, The Australian National University, Canberra, Australia.