Technology and the Future of Australian Jobs

What will be the impact of AI on workers in every sector?

November 2019

Foreword

The recent pace of technological advancement is unprecedented. Australia is in the midst of a major economic, social and political transition driven by global competition and rapidly expanding digital platforms and technological innovation.

Automation, Artificial Intelligence (AI), and the Internet of Things (IoT) is having an impact almost everywhere, in all industries, jobs and everyday life. Given this pace of change, it is important to understand and anticipate what this means for the future: jobs, youth, government and society more broadly, so that everyone has an opportunity to participate in the digital economy.

Over the next decade, more widespread adoption of existing technologies, plus rapid improvements in emerging technologies such as AI, networked computing and advanced robotics, will drive the real costs of automation down and create opportunities for economic growth, whilst increasing productivity. There will also be a shift in what we know of as jobs and relevant skills, today. The future of work will change, as technology evolves. There will be an impact to jobs across the economy – but what does that look like from an industry perspective in Australia?

To uncover key insights and build our understanding, we worked with Oxford Economics (initially in the United States (US) and the Association of Southeast Asian Nations (ASEAN)) to develop a model that estimates how both displacement and job creation will be spread across the economy in the future. We also took a deeper look into key industries in Australia that contribute to GDP and employment, to understand which work activities and occupations will be affected, along with how individuals can move around the labour market. The results highlight the need for technology skills across jobs and industries as most jobs in the future have a technology focus. In addition to technology skills, the model highlighted that human skills will be most in demand, such as listening, speaking, critical thinking, negotiation, and persuasion skills. As technology takes care of repetitive tasks, the way is paved for the human factor to increase in importance and value.

At Cisco, we want to understand future research and contribute to the continuing dialogue on technology's future impact. We believe Cisco has a role to play. We hope to serve as a catalyst for driving an inclusive digital economy. Our Digital Readiness Index, launched in September 2018, highlights that although Australia has been ranked one of the most digitally ready nations in the world, there is a significant 'digital divide' across states and territories. The time really is now to be taking action.

This study is a rich asset for policymakers and other stakeholders seeking to prepare Australians and industry for the skills demands of the future. As well as exploring technology's impact on jobs, we analysed the skills many of today's workers will need to develop, if they are to find sustained employment in the digital economy. These insights enable us to make investments that not only help meet industry demand for a digitally skilled workforce, but also help shape entirely new ideas and industries to fuel the digital economy and create the jobs of the future.

Executive summary

Over the next 10 years, the pace of technological change will be highly disruptive to the world of work. This era has the potential to deliver great rewards to the Australian economy through productivity growth. But as increasingly powerful Artificial Intelligence (AI)-led technologies are applied across industries, there are also understandable fears about the impact this will have on jobs. Significant parts of the workforce are at risk of being left behind if they are not prepared with the guidance and skills demanded by an evolving economy.

630,000

Number of jobs that could be displaced by new technologies over the next decade.

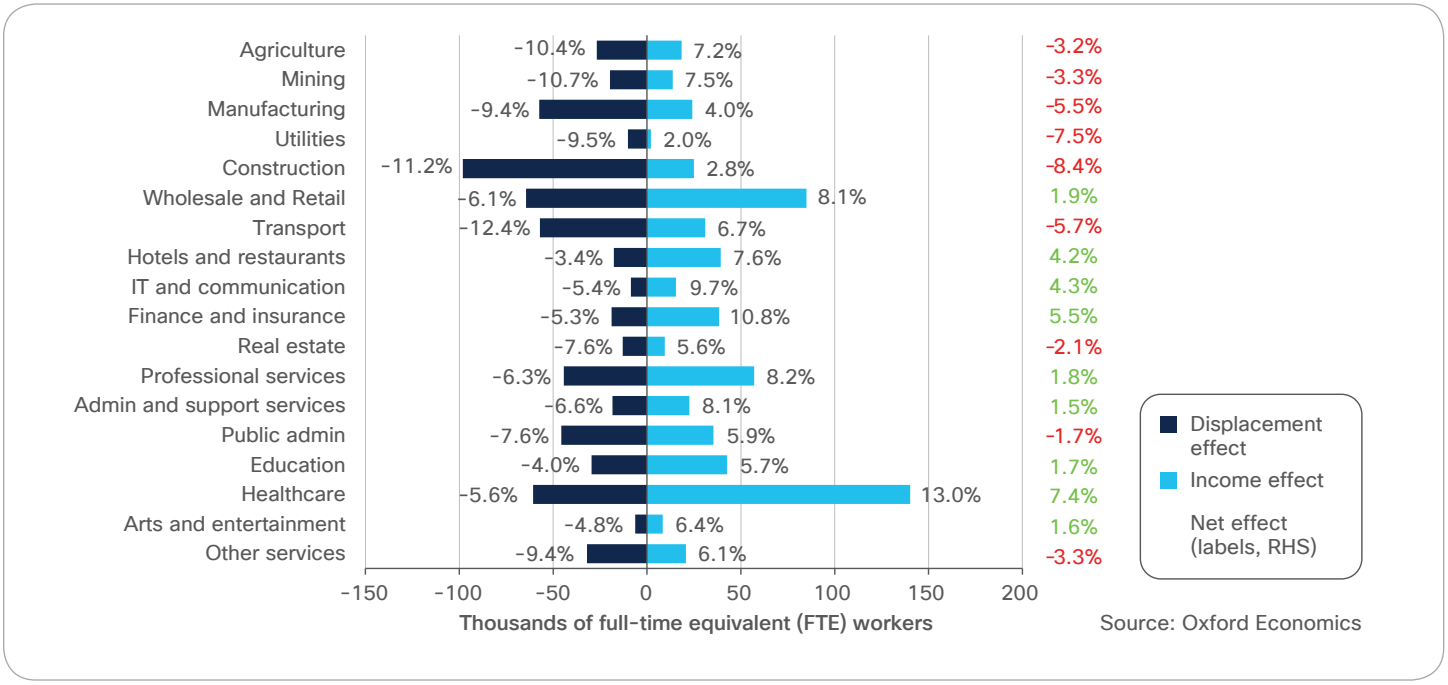
This equates to more than 7% of Australia's current workforce

Our analysis suggests that 630,000 jobs could be displaced by new technologies over the next decade. This "displacement effect" equates to 7.3% of the country's existing workforce. It represents the reduction in Australia's overall employment level that could be accommodated while still generating today's level of economic output in 2028.

The parts of the economy most likely to displace workers over the next decade in our scenario are typically those that show the greatest potential for productivity growth. As technology drives productivity upwards, this also creates an "income effect" on jobs. An expanding economy demands more workers to service its needs, not only in technical positions – designing, developing, creating and repairing new technology equipment, but much more broadly across industries. A shift in the labour market is caused when the sectors of the economy creating jobs do not map to the sectors where most jobs are lost.

Our analysis suggests healthcare will be by far the biggest net job creator in Australia over the next decade, expanding by 80,000 jobs (see Fig. 1). In this sector, the new job creation derived from higher consumer spending by far outstrips the displacement effect of new technology. The tourism and wholesale and retail sectors are also predicted to experience significant net increases in the sizes of their workforces, increasing by 22,000 and 20,000 workers respectively.

Figure 1. Net effect of technology scenario on jobs, by industry (number of workers and share of workforce, 2018-2028)



But other sectors will see their levels of employment shrinking. According to our model, the fastest-shrinking sector will be construction, which is predicted to lose more than 70,000 jobs (net) over the next decade—equivalent to around 8.4% of its current workforce. A further 33,000 jobs are predicted to be lost (net) in the manufacturing sector as a result of technological change, equivalent to 5.5% of that sector's workforce.

We are also able to analyse the changes in the labour market by occupational types. This tells us the greatest absolute burden from technological change will fall on "craft and trades workers" – a category that is projected to shrink overall by 80,000 jobs (net) over the next decade. In contrast, the category that will experience the largest expansion, with more than 90,000 net jobs created, is "professional occupations", which includes nurses, teachers, as well as software developers.

Where will the skills shortfalls hit hardest?

We use Oxford Economics' Skills Matching Model to simulate how the Australian labour market will evolve around this technological change. This model simulates the dynamics of the labour market to match workers to vacancies iteratively, based on historical job-matching probabilities and skills compatibility. By tracing the many incremental job moves that together realise the overall structural shift in the labour market, we can better understand the skills transitions that workers will be required to make.

We find that there is a clear and acute shortfall in science, technology and mathematics skills that must be filled if the Australian economy is to realise the promises of technology-driven growth. Our analysis suggests that the best available candidates would have to overcome a significant skills shortfall to meet the requirements of IT-related jobs. On average, they are 57% short of the programming skills requirements, projected for 2028. In sophisticated cognitive skills, such as maths and science, the best available candidates are up to 30% short of the skill levels new positions require.

An acute future shortage is also apparent in maintenance, installation, and technical repair skills. The best available candidates to fill such vacancies, according to our model, will typically be 25% to 35% short of the skills demanded by these roles.

But the Australian labour market will evolve in a way that demands more widespread skills transitions. For example, our model suggests more than 350,000 workers will be moving into jobs that require an upgrade to their listening, speaking, and critical thinking skills over this period. Some 150,000 workers will need to upgrade their negotiation, persuasion and learning skills. We see these softer, more human skills becoming increasingly in demand in the more technologically advanced economy of 2028.

Implications for policymakers, educators, and employers

This study highlights important implications for the stakeholders responsible for preparing Australia's workforce for the future. Policymakers face a dilemma between seizing the economic advantages new technologies will bring and managing the repercussions they will have for the workers that bear the brunt of the transition. Many workers will have to adapt not only their skillsets, but potentially their working habits and location, to meet the demands of the new economy. Policymakers must ensure that they understand how the implications will vary across different cohorts of the labour market and have measures in place to provide support where it is most needed to aid the transition. In parallel, the government must create an environment in which the skills demanded by businesses as they integrate the next generation of technologies can be delivered quickly.

In this context, educators and employers play a critical role. Education providers must ensure a pipeline of skilled workers is in place to feed into the workforce. This includes relevant formal training for new entrants to the labour market, as well as a much broader base for lifelong learning and more flexible training provision. This includes embracing technology solutions to deliver timely and relevant training in unison with employers. In addition, employers must take responsibility for smart, on-the-job training solutions required to retain the institutional knowledge of existing staff, whilst upskilling their wider workforce in parallel.

Contents

Introduction

In 2017, Cisco and Oxford Economics teamed up to construct a ground-breaking labour market modelling tool to explore the future skills challenges facing the US economy in response to technological change.[1] Leveraging the objective views of a broad panel of Cisco technology experts, this multi-layered modelling framework was designed to simulate how the nature of occupations and the shape of the labour market might evolve in response. It provided us with a platform for exploring the reskilling implications for policymakers, businesses, technology companies and workers seeking to smooth the transition.

In this report, we use this unique modelling tool to analyse the skills challenges facing the Australian economy. With technological change unfolding more rapidly than ever, no-one is invulnerable to disruption. Stakeholders across all sectors of the economy are asking what Australian workers must do to be ready for the opportunities and challenges that digital technologies present. How will healthcare, a fast-growing sector and the biggest employer in Australia, be affected by the wave of new technologies that could be implemented in the next 10 years? How exposed is the construction sector, another cornerstone of the Australian economy, to technological automation? This study projects how Australia's labour market will most likely evolve around the changes technology will bring.

Many jobs will be displaced, but many others will be created, as productivity gains drive the Australian economy forward. Some prominent roles in today's economy, such as finance managers and bartenders, may continue to play a significant role in a decade's time, while others, such as lorry drivers and office clerks, reduce in number in a more digitalised economy. We explore what the implications will be from the bottom to the top of the Australian skills hierarchy, assessing the reskilling challenges that workers across all sectors will face. We also contrast these results with our previous analysis of the US and selected ASEAN countries[2], to test the relative future-readiness of the Australian labour market.

Our modelling tool takes us forward in time to 2028, where we simulate the impact of technological advancements on the nature of work and the shape of the jobs market. While, in reality, these changes will be gradual and simultaneous, we report our analysis in four distinct sections, as follows:

- In Chapter 2, we assess the jobs that will be displaced by technology.
- In Chapter 3, we look at the jobs that will be created.
- In Chapter 4, we map these dynamics together, to explain the overall impact on jobs in each sector of the Australian economy.
- Then in Chapter 5, we model the transition from today's balance of employment to that of 2028, using Oxford Economics' Skills Matching Model to analyse the skills transitions that Australian workers will have to make.
- In Chapter 6, we present the conclusions of our study.

[1] **The AI Paradox: How Robots Will Make Work More Human,** Oxford Economics/Cisco (2017)

[2] Technology and the Future of ASEAN jobs, Oxford Economics/Cisco (2018)

Glossary of common terms in this report

Technology scenario – a set of scenario assumptions, developed with a multi-disciplinary team of experts in a series of structured workshops, originally regarding the United States.

Task profile – a profile of the tasks that constitute each of 433 occupations in the Australian labour market. The profile includes only those tasks deemed "important" to performing an occupation and weights the tasks according to the relative time they take up. Data on tasks is derived from the O*NET database (see Appendix 3).

Displaced worker – this refers to a worker who loses his or her job as a result of automation. In fact, technology only displaces workers from performing certain tasks within their overall task profile in our modelling framework. – When aggregated, – we consider each Full Time Equivalent (FTE) unit of labour as a displaced worker.

Redundant job – a job that exists in our 2018 labour market but is no longer required in 2028 under our technology scenario. Redundant jobs occur when the displacement of jobs outweighs the job creation for a particular occupation in any given sector of the labour market.

Vacancy – a job that exists in our 2028 scenario that did not exist in the 2018 baseline. Vacancies occur when the creation of jobs for a particular occupation in a given sector of the labour market outweighs the numbers of jobs displaced.

Income effect – the creation of new demand for workers as a result of our 2028 technology scenario. Technology leads to productivity gains, which drives down prices and boosts real income, which is spent on new goods and services and demands new workers.

Box 1: Modelling the long-term impact of technology on jobs

This study uses the modelling apparatus developed by Oxford Economics and Cisco as part of our 2017 study, **The AI Paradox: Making Work More Human**. In order to develop a bespoke analysis for the Australian context, we have adapted that framework to detailed Australian employment and macroeconomic data. We assess not only how the shape of the Australian labour market will evolve in response to technological change, but also which workers will move where during the transition—and the skills challenges these moves will raise.

Our methodology can be described in five parts:

Assess productivity implications for workplace tasks

We leveraged in-house expertise from a range of Cisco technology experts to explore the implications of technological change on jobs. We developed a comprehensive set of assumptions about the impact that technology could have on the tasks and functions people perform in the workplace. In this study, these expert insights are applied to the Australian context.

Modelling the implied 'displacement effect'

We developed occupation-specific task profiles for 433 occupations in the Australian labour market, based on a 41-task typology produced by O*NET (see Appendix 3). We modelled the scale of technology-induced displacement implied by our technology assumptions to assess the impact on different workers. We found that many fewer hours would be required to perform the same range of tasks, reflecting technology-driven productivity gains.

Modelling the long-term 'income effect'

The productivity gains implied by technological change will lead to faster economic growth, and the dividends of that growth will be spent on more goods and services in the economy. We used Oxford Economics' Global Industry Model as a basis for estimating how these productivity gains will be distributed across Australian industries. We then estimated the extra workers that would be required to meet that demand, even in the context of technology improvements.

Forecasting the 2028 labour market

We brought these two perspectives together to forecast the new shape of the labor market in 2028. We then used the Oxford Economics Skills Matching Model to predict how today's workforce will make that transition to the future. Our model simulates how workers move through the labour market, away from redundancies in some occupations and into vacancies in others, in response to these changing conditions.

Analysing the reskilling challenge

Finally, we delved deep into our labour market projections to trace the moves that workers are likely to make to adjust to this changing landscape. Based on the occupational background and skill level of those workers, we identified the reskilling challenges they would face in their new jobs and examined what this would mean for the Australian economy as a whole.

Technology displacing Australian workers

The technology that exists in the modern economy is already powerful enough to replicate and improve many of the functions workers spend their days performing. Over the next 10 years, these technologies will become more powerful and efficient, and will find new applications across many different industries as more businesses use them to their full potential.

In this chapter, we use a task-based lens to assess the potential impact this change could have on the jobs landscape by 2028. The impact on each worker will depend on two factors:

1. **The task-profile that defines each occupation.** This refers to the specific balance of tasks a worker performs in their job each day.
2. **The extent to which the application of technology will outperform a human worker on each specific task in 10 years' time.**

Our modelling assumptions are informed by a technology scenario developed with a range of Cisco technology experts – see Appendix 1 for more details.

2.1. Displaced workers: Impact by industrial sector

Our modelling suggests that 630,000 workers could be displaced by technology by 2028. This means that, after a decade of technological advancement, today's level of economic output could be produced by 7% fewer workers across the Australian economy.

This 'displacement effect' is most apparent in the transport sector, in relative terms. We calculate that 12.4% of its workforce will be displaced over the next decade[3] – equivalent to 57,000 full-time equivalent (FTE) jobs. Both the construction and agriculture and mining sectors also face displacement levels exceeding 10% of their workforces (see figure 2).

The relative vulnerability of these sectors to technology-driven displacement is a result of the nature of their work. Workers spend more time operating vehicles, handling objects and controlling machines, all of which have the potential to be completed more efficiently with the application of new and existing technologies, such as advanced robotics and machine learning.

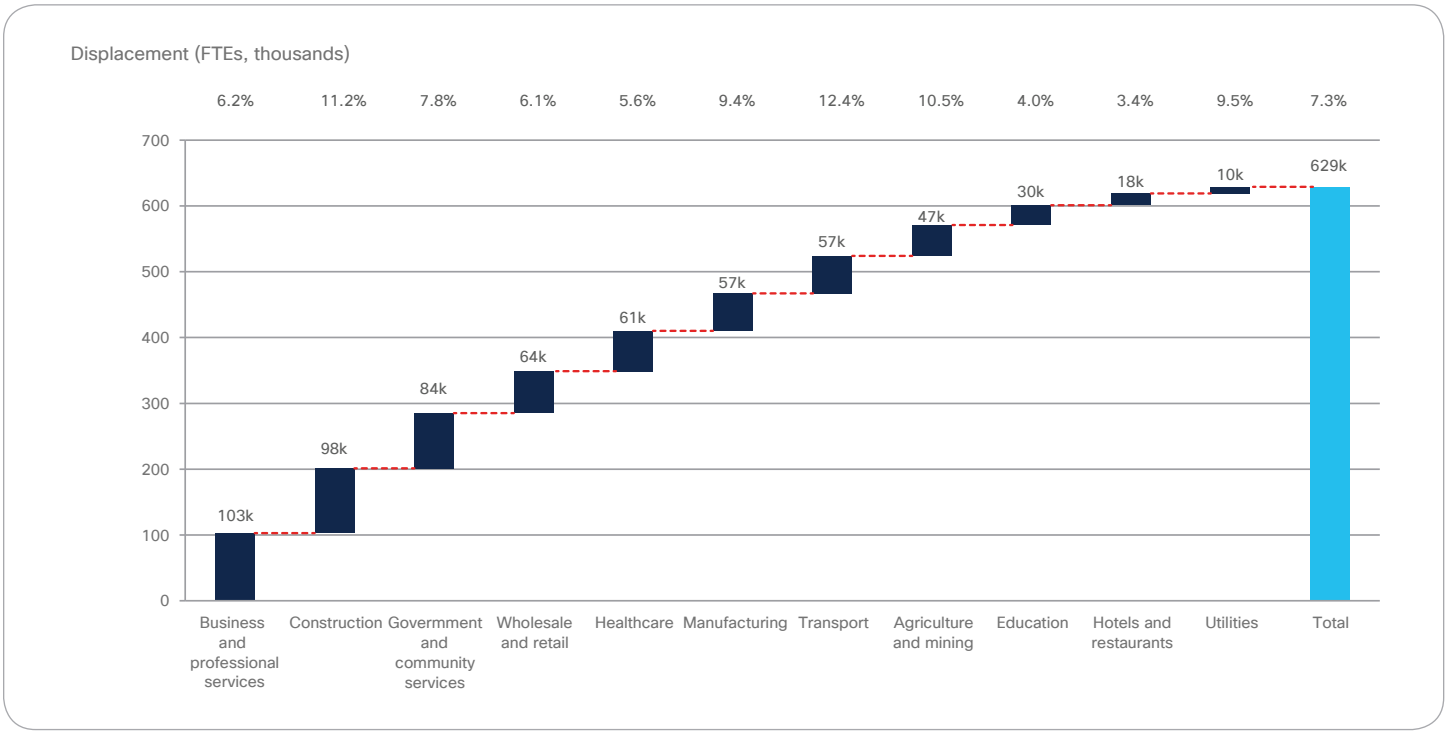
In absolute terms, we find that business and professional services will be the most severely affected sector, accounting for more than 100,000 of the country's displaced workers.[4] This is largely because business and professional services is the largest sector in Australia, employing almost 20% of today's workforce. In comparison, the construction, manufacturing, and transport sectors together are projected to see 210,000 workers displaced – a third of the overall displacement effect.

Our modelling identifies hotels and restaurants and education as the least-vulnerable sectors to technological displacement over the next 10 years. There are opportunities for technology to enhance productivity and raise the quality of service in these two sectors, such as automated hotel check-in and virtual learning environments. But for many roles in these sectors, from bartenders to primary school teachers, elements of the day-to-day work such as social interaction, team-building and resolving conflicts are critical. These human-facing, non-routine activities are less vulnerable to automation according to our technology scenario, and therefore, despite advancements in technology, humans will still tend to outperform in these tasks.

[3] The timeframe of our analysis was 2018 to 2028.

[4] Business and professional services is an aggregation of the following sectors; IT and communications, Finance and insurance, Real estate, Professional services, Administration and support services.

Figure 2. Technology-driven displacement of jobs, by aggregated industry[5] (Number of workers and share of workforce, 2018-2028)



2.2. Displaced workers: Impact by occupation

The displacement potential of technology on different industries is driven by their specific mix of employment, and the nature of the work they conduct. In fact, it is the unique blend of tasks performed by different occupations – what we refer to as their "task-profile" – which determines a given worker's exposure to technological displacement. We analysed 433 Australian occupations to understand which occupations bear the greatest burdens of technological displacement.

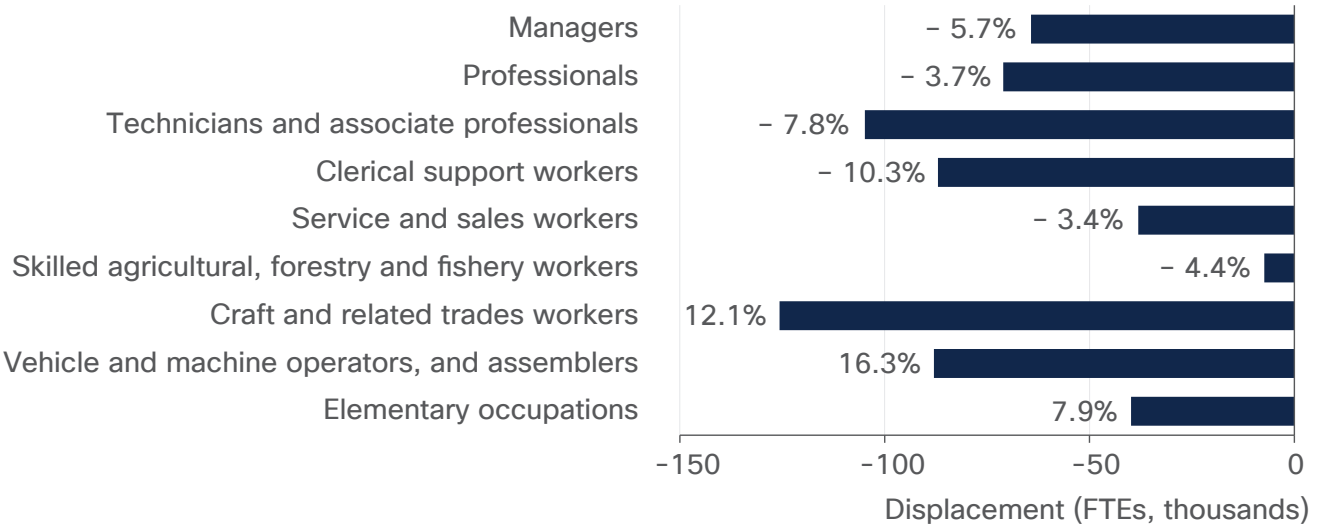
According to this occupational analysis, jobs categorised as **vehicle** and **machine operators and assemblers**[6] are most vulnerable to the predicted technological developments, in relative terms. More than 16% of these workers – who include lorry drivers, taxi drivers, and machinery operators – are projected to be displaced by technology in the next 10 years (see Fig. 3).

In absolute terms, **craft and related trades workers** – which includes mechanics and carpenters – will be most affected, followed **by technicians and associate professionals**. Both categories are projected to see more than 100,000 workers displaced under our scenario. For further insights into how new technology will affect different types of occupation, see Box 2 overleaf.

[5] Government and community services consists of public administration, arts and entertainment, and other services.

[6] This is a relabelling of the ISCO Rev4 category "plant and machine operators, and assemblers", which was done to provide more clarity that vehicle drivers, a prominent type of occupation in Australia, is included in this category

Figure 3. Technology-driven displacement of jobs, by occupation group (Number of workers and share of workforce, 2018-2028)



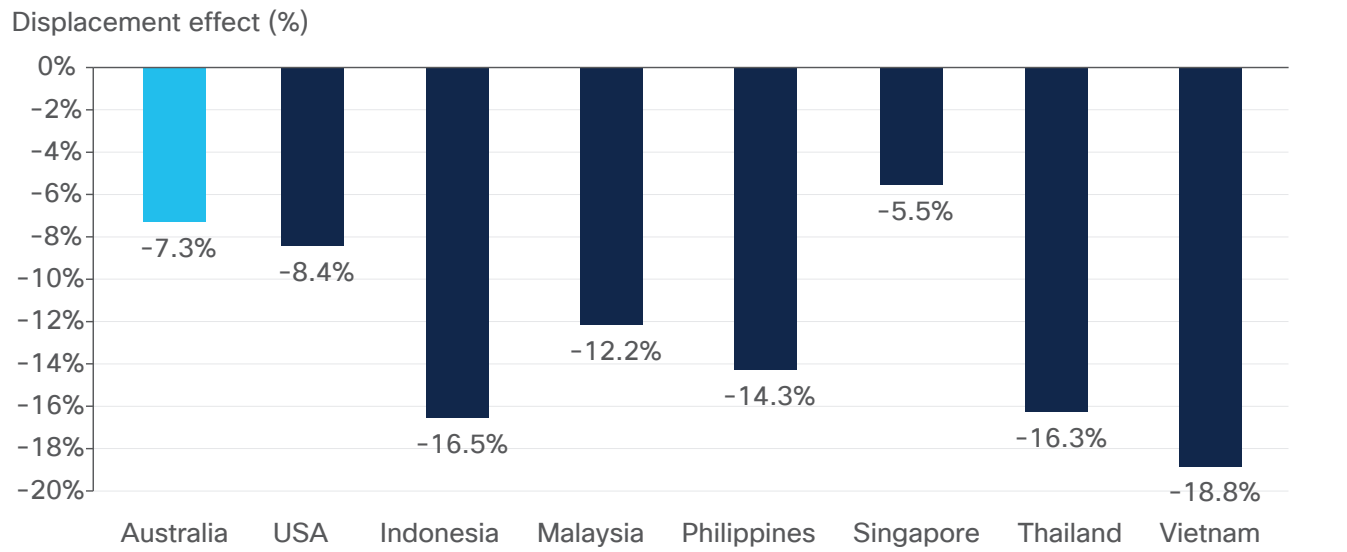
Source: Oxford Economics

2.3. How does australia compare to other countries?

Australia's workforce is relatively less vulnerable to job displacement than the United States and most of the ASEAN countries we have analysed. Under the same set of modelling assumptions, we expect 7.3% of Australian jobs will be subject to displacement by 2028, compared with 8.4% of the US workforce (see Fig. 4). In relative terms, Australia is much less vulnerable to automation than Vietnam – which faces 18.8% displacement – Indonesia, Thailand, the Philippines, and Malaysia. In contrast, Singapore, an urbanised, heavily service-sector oriented economy, appears to be more resilient than Australia to technological change, with only a 5.5% displacement of its current workforce predicted under the same assumptions.[7]

[7] Displacement effect reported here may differ from published results because modelling assumptions were harmonised across regions for sound comparison.

Figure 4. Country comparison of technology-driven displacement effects[8]



Source: Oxford Economics

Australia's relatively advantageous position in the face of major technological disruption is the result of the structure of its labour market. Relatively fewer people in Australia are employed in jobs whose task-profiles are most vulnerable to technological change, such as capturing and monitoring information, and manual labour.

Nonetheless, the Australian workforce will still face significant challenges, as its jobs landscape shifts in response to labour savings and productivity gains. In the next chapter, we explore where the growth of new jobs will be concentrated (both in terms of sectors and occupations), before going on to assess how difficult the transition for displaced workers will be.

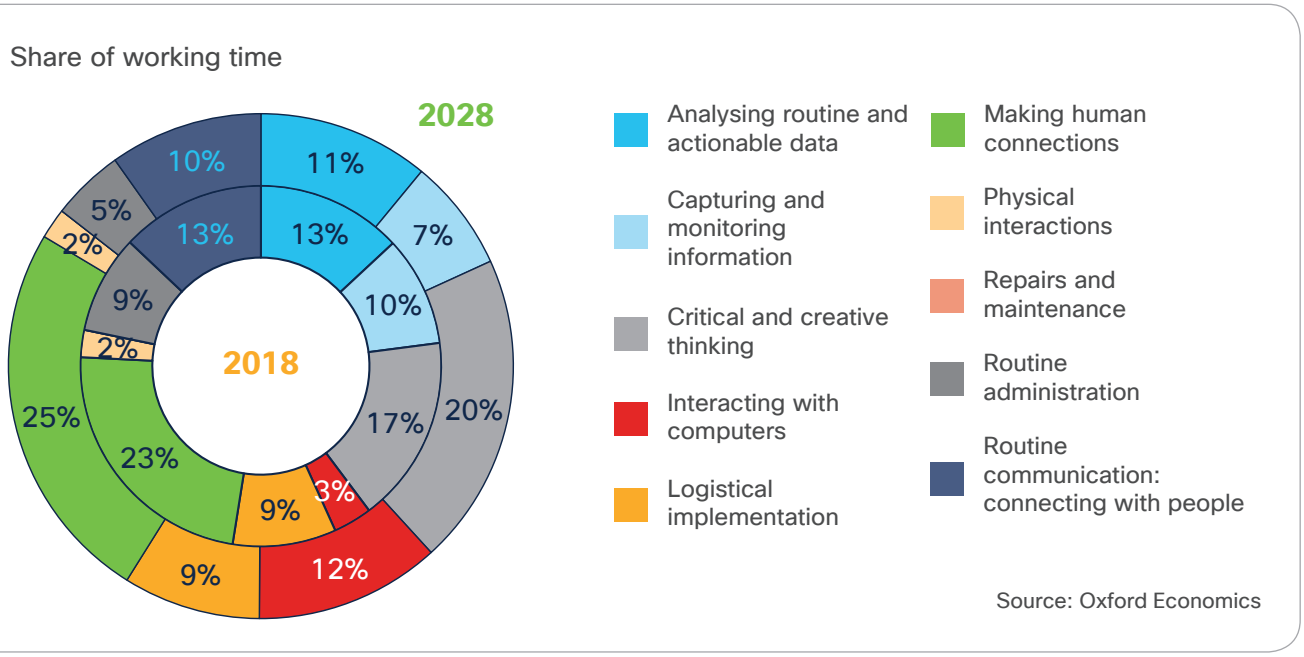
[8] The same assumptions regarding the extent to which technology will alter the productivity of workers undertaking certain workplace tasks are applied to each country.

Box 2: How does new technology change the nature of work?

To model the impact of technological change on the Australian labour market, we developed 433 unique task-profiles to describe the full range of occupations. Each profile contains a basket of tasks classified "important" to performing that particular job. While more complex occupations tend to require a balance of multiple important tasks, no occupations are entirely dependent on a single task. The displacement effect is determined in part by the make-up of tasks for a given occupation.

To shed further light on our analysis, we have selected an occupation at either end of the "vulnerability spectrum" in Australia – nurses and construction labourers. Figs. 5 and 6 illustrate how the nature of work in these occupations changes over the next 10 years.

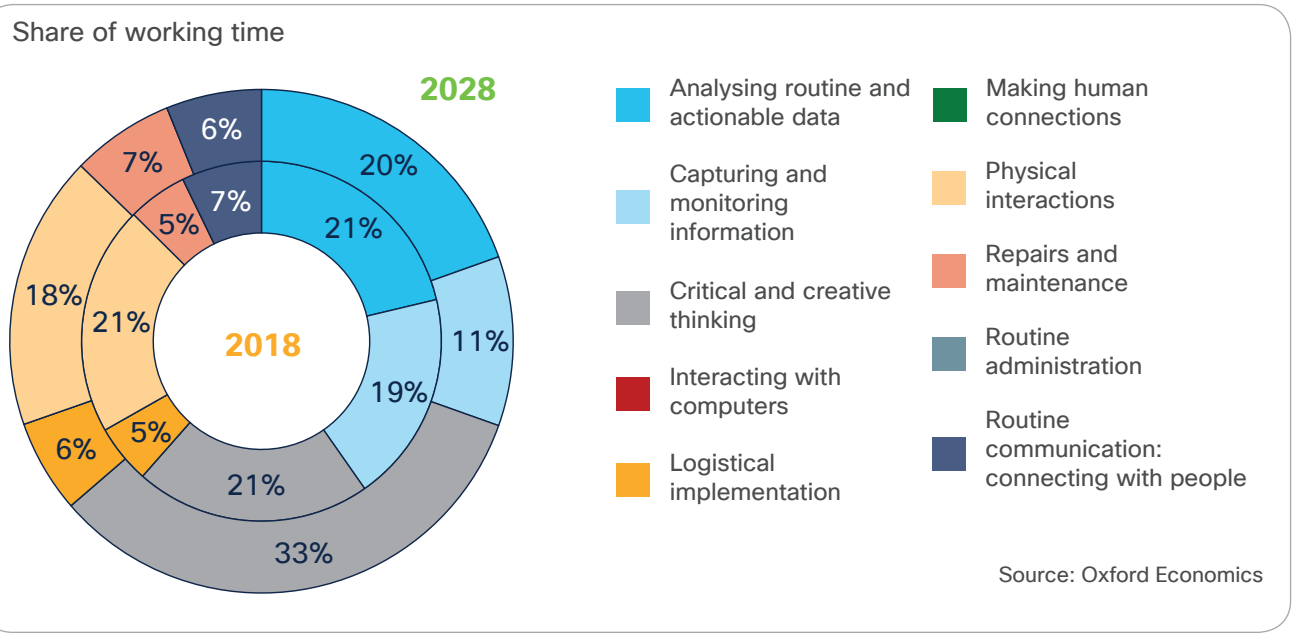
Figure 5. Projected change in task-profile of a nurse, 2018 to 2028



Source: Oxford Economics

The **healthcare sector** is the biggest employer in Australia. Its strong recent growth is predicted to continue along with the country's ageing population. Nurses are the largest occupation in this sector and, despite significant advances in technology's use in healthcare, are among the least vulnerable to technological automation. Nurses spend a large proportion of their time making human connections that are very difficult for a robot to replicate and this will continue to be a pivotal aspect of their work. However, we predict nurses will spend less time engaging in routine administration and communication, with more time instead spend critical thinking and interacting with computers.

Figure 6. Projected change in task-profile of a construction labourer, 2018 to 2028



The **construction sector** is Australia's third-largest employer. Unlike nurses, the nature of work conducted by construction labourers means they are more vulnerable to technology-driven displacement. Today, construction labourers spend a significant amount of time engaging in physical activities and capturing information. In 10 years' time, we predict that these tasks will typically constitute a smaller share of their working time. More of their time will be taken up by critical thinking, and by repairs and maintenance of the additional technological equipment that is used across the construction sector in 2028.

Jobs created by technological change

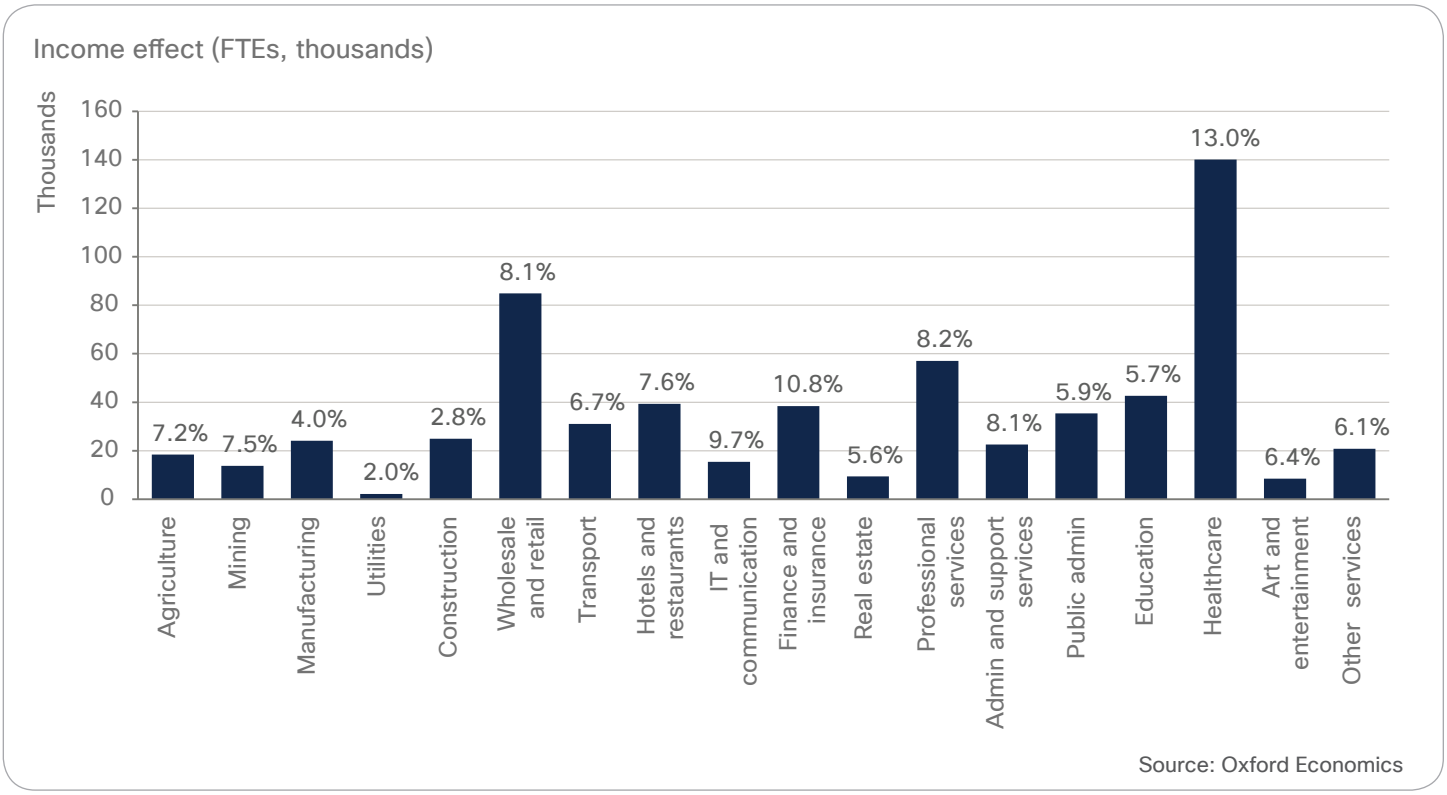
Businesses do not invest in new technology to put human workers out of a job, but to strive for greater productivity and higher performance. For every job displaced by technology under our 2028 scenario, there is a productivity gain achieved. By enhancing productivity, new technologies drive down the cost of production, which in turn lowers the prices of goods and services.

The consequential increase in demand for these products also creates demand for additional workers. This is known as the "income effect" of our technology scenario and occurs in parallel with the displacement effect analysed in Chapter 2. In this chapter, we forecast the income effect's impact on each industry sector and occupation group over the next decade.

3.1. Jobs created: Impact by industrial sector

Our analysis suggests the main growth sectors for jobs over the next decade will be healthcare, wholesale and retail, and professional services. Across these three sectors, 280,000 new jobs will be created as a result of new technology's income effect – 45% of the gross job creation over the next 10 years.[9] Australia's ageing population is a key driver of the growing demand for healthcare services, with the population aged 65-and-above predicted to grow by 34% over the coming decade, compared to 14% for the entire population. When the income effect is considered in relative terms, other sectors such as finance and insurance and IT and communication also rise to prominence (Fig.7).

Figure 7. Gross impact of income effect on jobs, by industry (Number of workers and share of workforce, 2018-2028)



Source: Oxford Economics

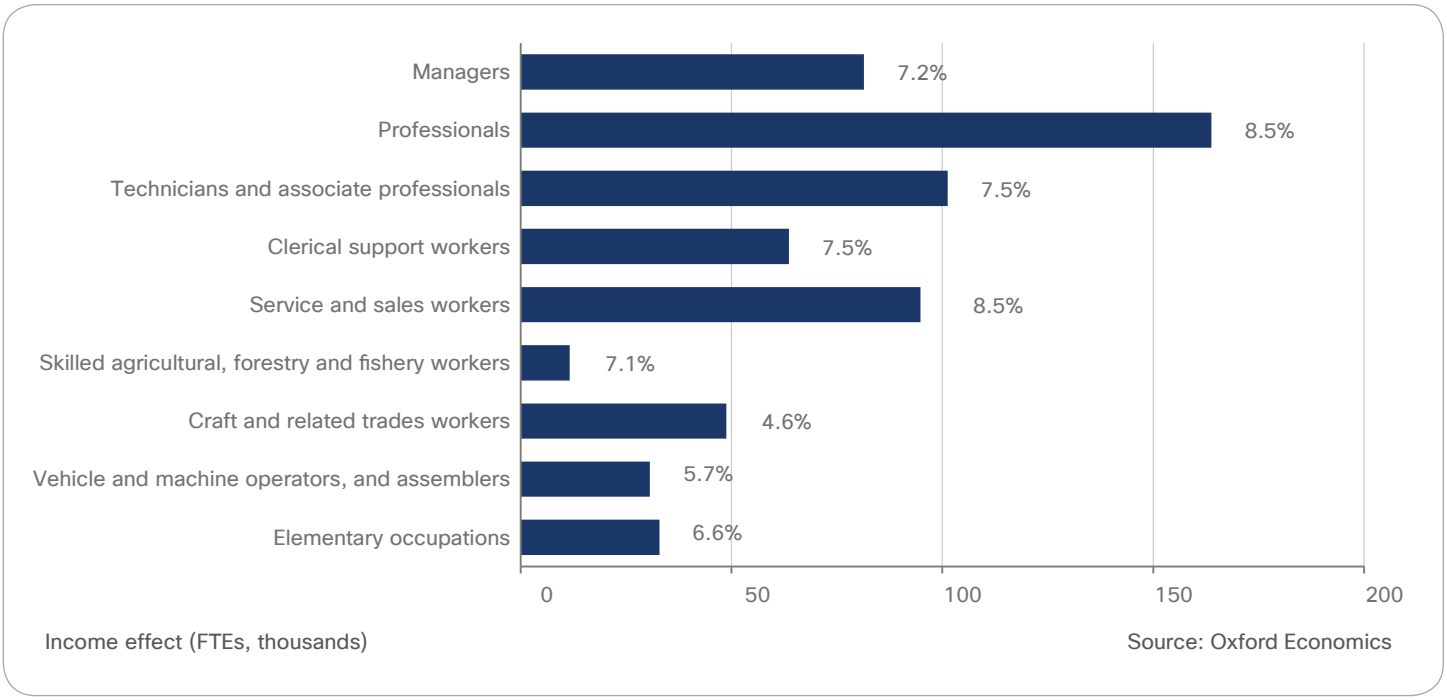
[9] Gross job creation refers only to increased demand for workers as a result of the "income effect", not counting the displacement effect analysed in Chapter 2, which offsets this.

3.2. Jobs created: Impact by occupation

The impact of technology's income effect on different occupations depends on the types of goods and services that people demand. Our analysis shows that rising levels of spending on healthcare and professional services in the next 10 years will result in a marked increase in demand for professional occupations, which includes accountants, lawyers, and marketing professionals.

We expect a similar relative increase in demand for service and sales workers (8.5%), despite the levels of automation taking place among this broad occupation type. This is because as the economy grows, people will spend much of their extra money within the wholesale and retail sector, which contains many of these jobs.

Figure 8. Gross impact of income effect on jobs, by occupation group (Number of workers and share of workforce, 2018-2028)



This evolution in the shape of the labour market will, of course, take place gradually. As businesses integrate technology solutions at different rates, the opposing processes of job displacement (Chapter 2) and job creation (Chapter 3) occur continuously. Significant new work opportunities will emerge in some sectors just as they are constrained in others, and workers will constantly adapt to the demands of the labour market.

In the next chapter, we illustrate how the twin forces of job displacement and job creation implied by our new technology scenario offset each other—and what this will mean for the future shape of the Australian labour market.

What will Australia's Labour Market Look Like in 2028?

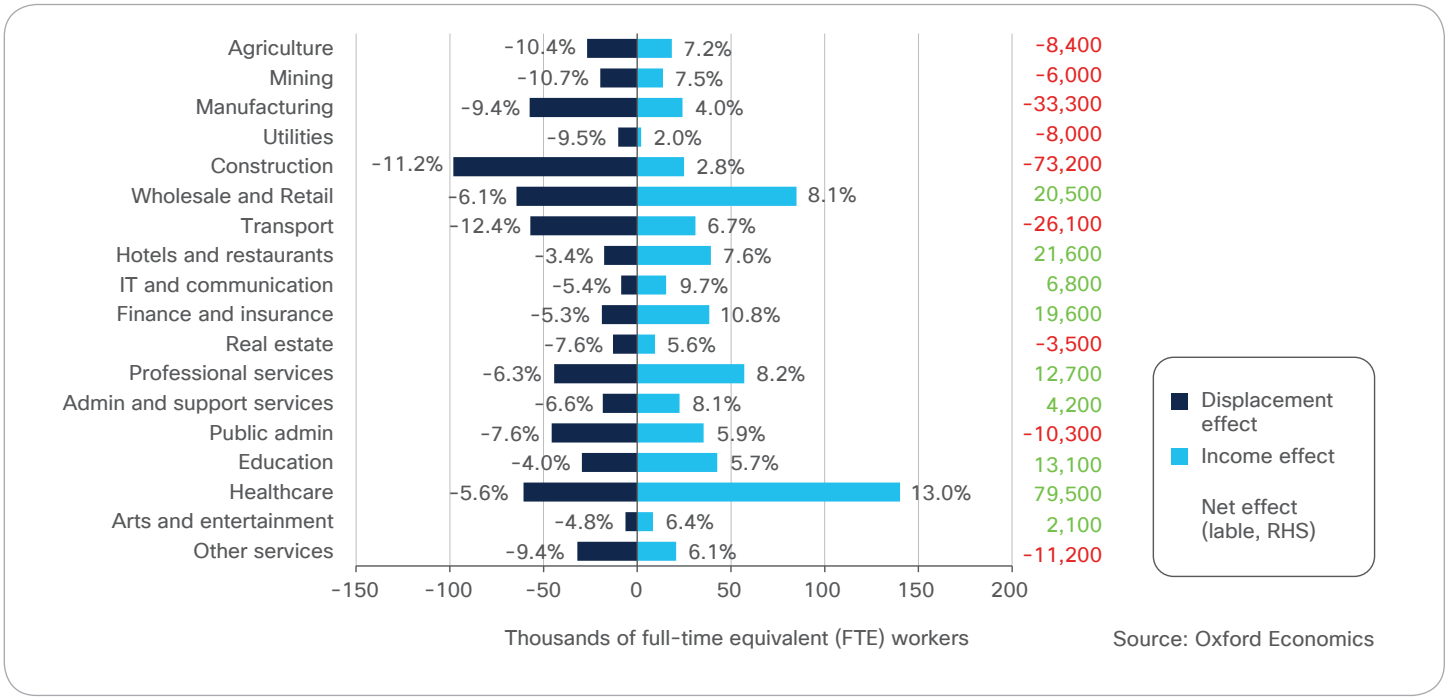
Our 10-year technology scenario explores the competing effects of technological change on the Australian labour market. In some cases, the growing economy will create enough jobs in a given sector or occupation group to outweigh the displacement of workers brought about by new technology. In other sectors and occupation groups, the opposite will be true, and they will shrink. As the two forces interact across all strata of the economy, the new shape of the Australian jobs market will take shape.

4.1. The overall impact on jobs in each sector

Our analysis suggests healthcare will be by far the most notable net job creator in Australia over the next decade. We predict a net expansion of around 80,000 jobs in this sector (see Fig. 9 for a breakdown of the income and displacement effects for each sector). Tourism and wholesale and retail are both also predicted to experience significant net increases in their workforces, totalling 22,000 and 20,000 workers respectively.

Other sectors will see their levels of employment shrink. These are the sectors that are ripe for technology-driven productivity improvements which will outcompete workers in the completion of important tasks. According to our model, the fastest-shrinking sector in employment terms will be construction, where the use of drones, cloud-based software applications, and wearable technologies all have the potential to enhance productivity while also reducing the risks faced by workers. This is predicted to result in a net loss of more than 70,000 construction jobs in Australia over the next decade – equivalent to around 8.4% of the sector's current workforce. A further 33,000 jobs are predicted to be lost overall in the manufacturing sector as a result of technological change, equivalent to 5.5% of that sector's workforce.

Figure 9. Net effect of technology scenario on jobs, by industry (Number of workers and share of workforce, 2018-2028)

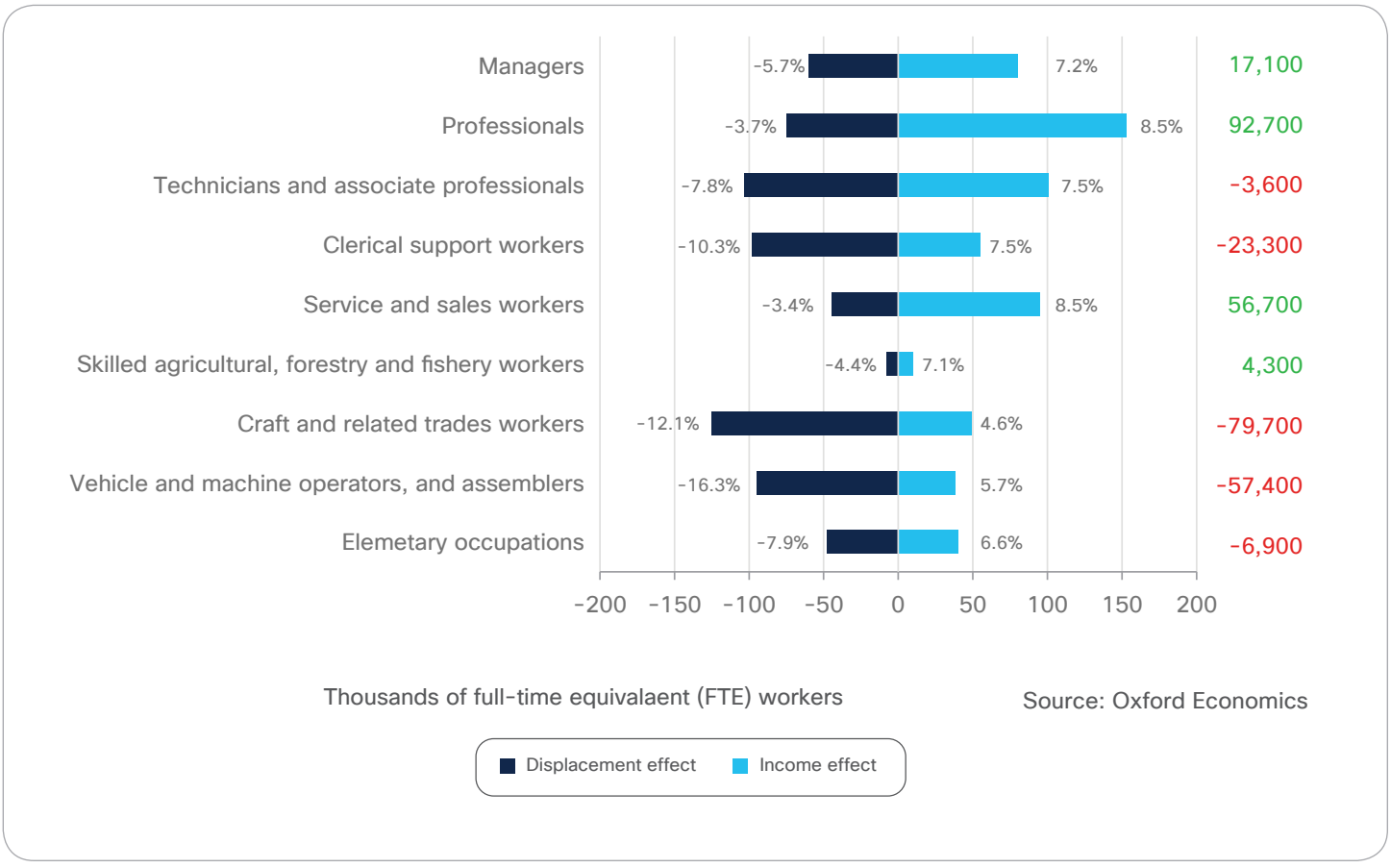


4.2. The overall impact on jobs in each occupation

Observing the overall impact through an occupational lens, our analysis suggests the greatest absolute burden from technological change will fall on craft and related trades workers – a category that is projected to shrink by 80,000 jobs over the next decade. In contrast, the category that will experience the largest net expansion, with more than 90,000 jobs created, is professional occupations, which includes nurses, teachers, and software developers.

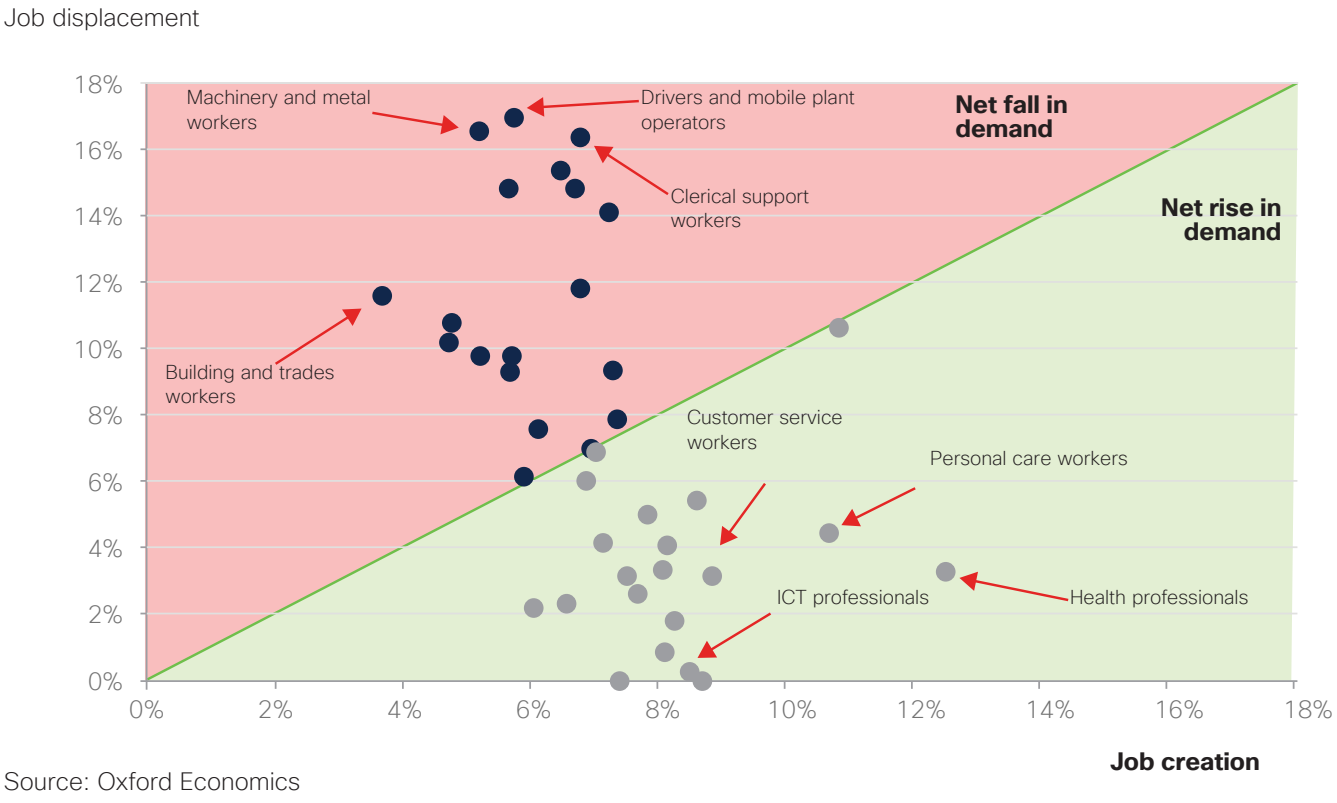
In relative terms, demand for extra workers is predicted to be strongest in service and sales roles. Our scenario suggests a 5.1% net increase in the demand for these workers in 2028, compared to a decade earlier. In stark contrast, vehicle and machine operators and assemblers are in line for the largest net reduction in demand, with 10.6% fewer roles predicted in 10 years' time (see Fig. 10).

Figure 10. Net effect of technology scenario on jobs, by occupation group (number of workers and share of workforce, 2018-2028)



To illustrate the implications of this shift in demand for workers, we present the net employment impact from an alternative perspective in Fig. 11. Each dot on this chart represents an occupational category. Those located below the green diagonal line are the categories that will demand additional workers in our 2028 scenario, with new job creation outweighing the number of jobs displaced. The occupational categories expected to experience the greatest net job creation (in relative terms) are those that are horizontally furthest from the diagonal, including health professionals and ICT professionals. This distance represents the net level of job creation, relative to the size of each sector.

Figure 11. Net rise or fall in demand for different occupations Job displacement versus job creation, by occupation category (2018–2028)



Source: Oxford Economics

On the other hand, occupation categories situated above the diagonal line on Fig. 11 will experience net job redundancies, with the negative displacement effect outweighing the positive income effect. This is the case for machinery and metal workers, and drivers and mobile plant operators, for example, whose job functions are in line for considerable disruption from new advances in robotics and autonomous vehicles. For this group of occupations, the vertical distance above the diagonal represents the net level of job destruction, relative to the size of each sector.

4.3. Transitioning to the workforce of the future

Underneath the high-level rebalancing of employment across industries, more complex dynamics are taking place. Businesses will respond to new technology based on the characteristics of their own workforce and production processes. Workers will be drawn into new jobs based on the changing demand for goods and services. The effect within an industry, therefore, is not uniform for all employees. Similarly, the impact on a particular occupation group will differ depending on which part of the economy they are employed in.

For example, clerical support workers are expected to shrink in number considerably over the next decade, by more than 23,000 in our scenario. However, that is not the case across all sectors. Fast-growing sectors such as healthcare and hotels and restaurants are still predicted to recruit new clerical workers in our scenario, as the growth in demand in these sectors outpaces the potential for automation.

To shed further light on these patterns, we have pulled together our sectoral and occupational analyses in Fig. 12, overleaf. This table summarises the net changes in employment between every sector and occupation group, with dark red squares indicating the largest overall job losses, and dark green the biggest overall job increases.

The table thus provides a detailed insight into the way the Australian labour market will reorganise itself, with work gravitating towards roles in which humans can add most value working alongside technology, and towards industries that supply the goods and services for which there is most growth in demand.

All workers will be forced to adapt, but the transition will be much harder for some than others. Some workers will remain employed in their current field but will need to adapt to the evolving demands of their role. Others will need to transition to new roles or new industries altogether. The routes that these disrupted workers take to their new roles are what defines the skills challenge for the Australian labour market. In the next chapter, we employ Oxford Economics' Skills Matching Model to analyse this skills challenge in greater depth.

Figure 12. Net change in employment, by industrial sector and occupation group (2018-2028)

Occupation group	Agriculture and mining	Manufacturing	Utilities	Construction	Wholesale and retail	Transport	Hotels and restaurants	Business and professional services	Government and community services	Education	Healthcare	Total
Managers	-2,440	-800	-260	-1,930	470	980	-1,510	12,700	2,630	1,510	5,790	**17,140**
Professionals	730	-440	-520	-740	3,560	680	290	26,700	3,350	15,390	43,740	**92,740**
Technicians and associate professionals	-650	-2,910	-1,160	-6,670	50	-1,660	5,140	1,460	-3,940	-950	7,720	**-3,570**
Clerical support workers	-1,030	-4,030	-1,170	-4,870	3,000	-4,150	1,000	-3,500	-8,210	-4,130	3,770	**-23,320**
Service and sales workers	210	250	-50	-80	18,470	710	12,820	2,760	3,980	1,320	16,340	**56,730**
Skilled agricultural, forestry and fishery workers	860	-50	0	480	150	-30	210	1,590	630	230	280	**4,350**
Craft and related trades workers	-3,370	-13,200	-2,200	-43,330	-3,160	-1,500	230	-1,120	-12,360	-200	460	**-79,750**
Vehicle and machine operators, and assemblers	-5,990	-10,900	-2,230	-6,780	-4,460	-20,870	-1,160	-1,750	-2,330	-180	-740	**-57,390**
Elementary occupations	-2,700	-1,240	-430	-9,280	2,410	-210	4,610	910	-3,180	60	2,120	**-6,930**
Total	**-14,380**	**-33,320**	**-8,020**	**-73,200**	**20,490**	**-26,050**	**21,630**	**39,750**	**-19,430**	**13,050**	**79,480**	**0**

The skills challenge facing workers and employers

What does our projected change in the 2028 jobs landscape mean for Australian policymakers, employers, and workers as they ready themselves for the future demands of the economy? Today's workforce does not possess many of the skills and experience that the future economy will demand of it. The better that these shortcomings are understood, the better prepared these various stakeholders will be to smooth Australia's transition to a more technologically advanced, productive, and larger future economy.

For the next stage of our study, we used Oxford Economics' Skills Matching Model to simulate iteratively how all the job vacancies that result from our technology scenario will be filled in 2028.

To do this, it is not enough to understand where, ultimately, jobs will be created and lost in the economy, since this misses all the incremental job changes in the middle. For example, we would not expect each displaced taxi driver to retrain as a healthcare assistant or software designer. Instead, there will be a "ripple effect" throughout the economy, as most affected workers seek out new jobs with task-profiles closely aligned to their own.

Our Skills Matching Model is designed to simulate the mechanisms that play out in the real-world labour market. This enables us to explore the routes to new employment that displaced individuals will most likely take, and the additional skills they will require to get there.[10] (See Appendix 2 for more information on how this model works.)

5.1. Where is the skills challenge most acute?

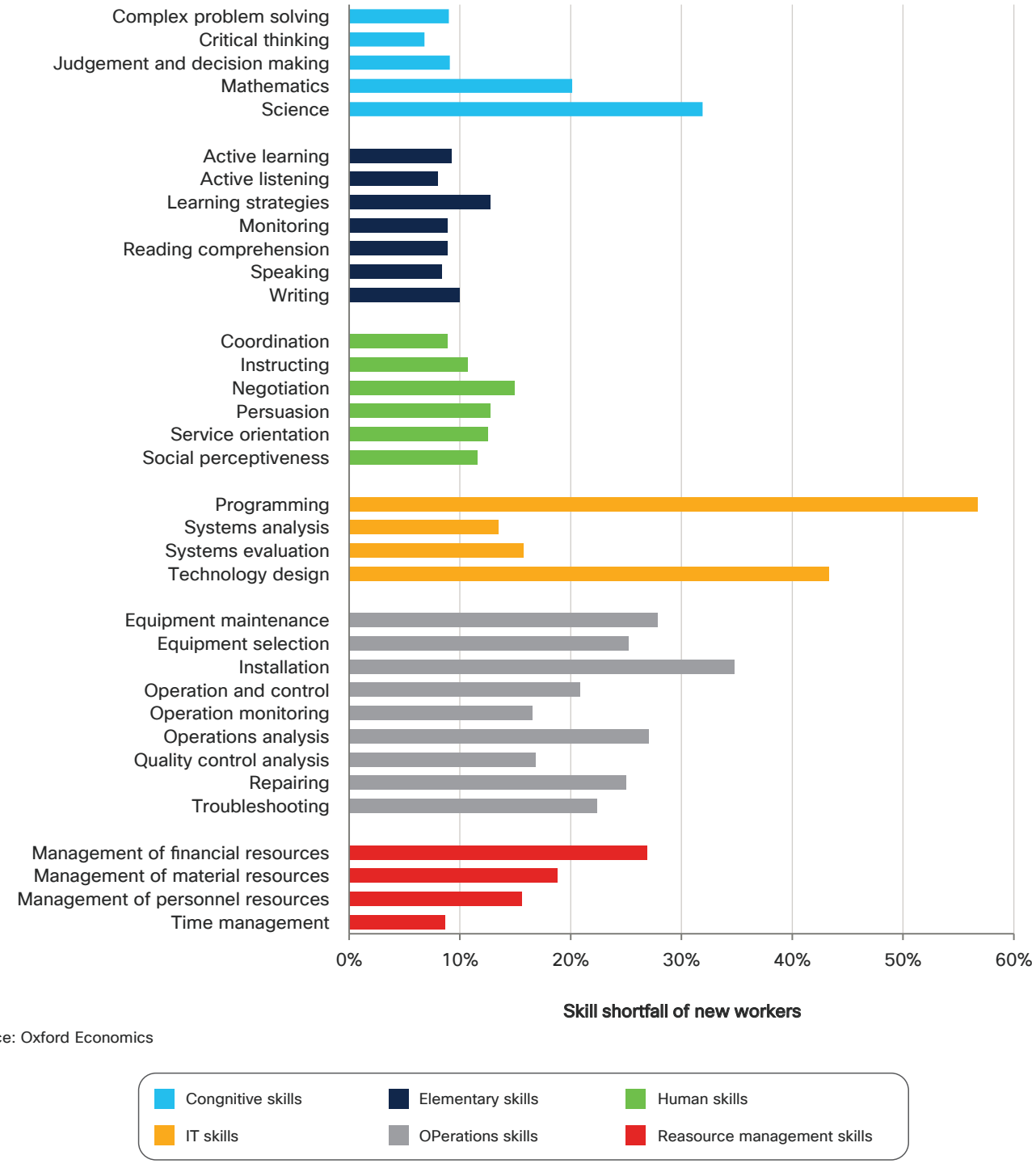
Our analysis shows that today's workforce faces the most acute challenge in terms of acquiring the required level of new IT skills. For example, the workers most likely to be pulled into occupations needing programming skills are found to fall 57% short of the overall level required in our 2028 technology scenario. Similarly, for technology design, workers are estimated to be 43% short of the economy's future requirement.

For jobs requiring the complex cognitive skills of maths and science, employers will be drawing from a pool of labour that currently falls, respectively, 20% and 30% short of where it needs to be. Such highly technical occupations will be in great demand in future and are at the heart of delivering the kind of technological progress that define our 2028 scenario.

Relatively acute skills challenges also show up in other technical areas. Our model suggests today's workforce is not sufficiently prepared for future jobs demanding operations skills such as equipment maintenance, installation, operations analysis, and technical repairs. In these skill areas, the best available candidates to fill emerging positions are currently 25 to 35% short of the levels required, overall. In Fig. 13, below, we set out the Australian labour market's full skills challenge, with the skills grouped into six overarching categories.

[10] The Skills Matching Model focuses on those workers that change occupations as a result of the creation and displacement of jobs across industries and occupations. Many displaced workers are in fact "re employed" in the same occupation and industry in our 2028 scenario as today, as a result of the income effect offsetting the displacement effect, and they are therefore excluded from this analysis.

Figure 13. Overall skills shortfall of today's workers in 2028 economy



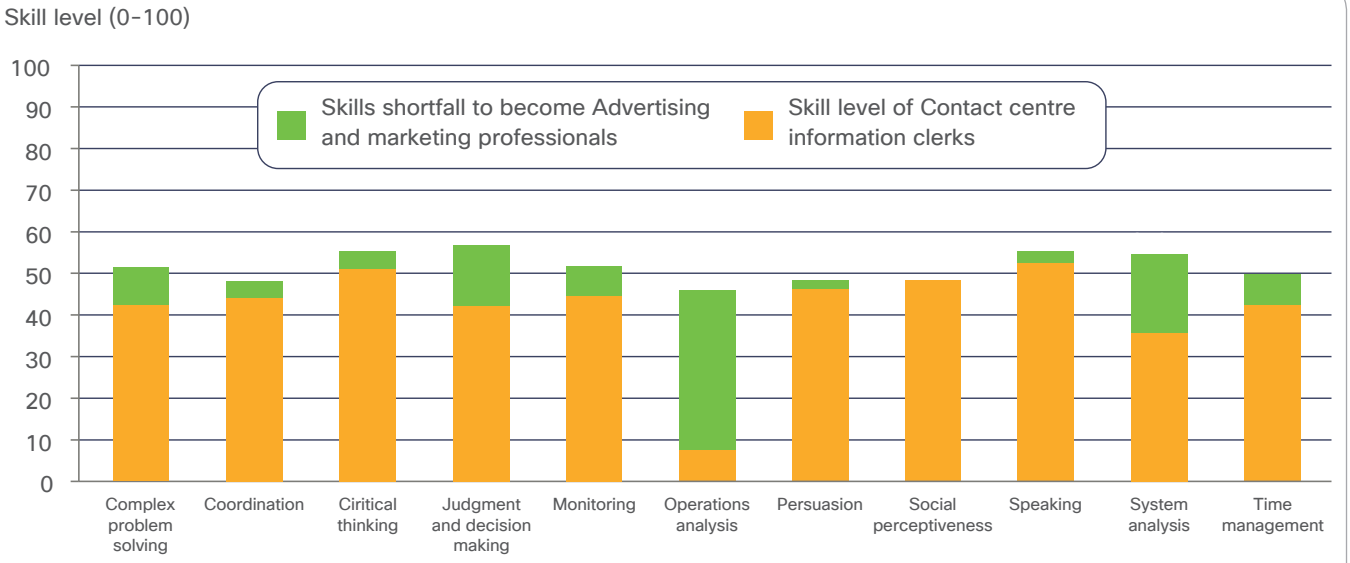
Source: Oxford Economics

Box 3: A real-world application of our skills shortfall analysis

To illustrate how skills shortfalls are estimated, we present an example of a common job move in our model: a contact-centre clerk becoming an advertising and marketing professional. The contact-centre clerk has adequate skills to complete some aspects of the advertising role, such as those relating to social perceptiveness and speaking. But the clerk would face a significant learning curve in others. The advertising and marketing jobs typically require higher skills in operations analysis, systems analysis, and judgement and decision-making.

In order to estimate the size of her "skills shortfall", we quantify the skills profiles of both occupations, using O*NET data (see Appendix 3) and the difference between them. The clerk's shortfalls for each task are illustrated by the light-blue areas in Fig. 14.

Figure 14. Skills shortfall for contact-centre clerk becoming an advertising professional



Source: Oxford Economics

5.2. How widespread is the skills challenge?

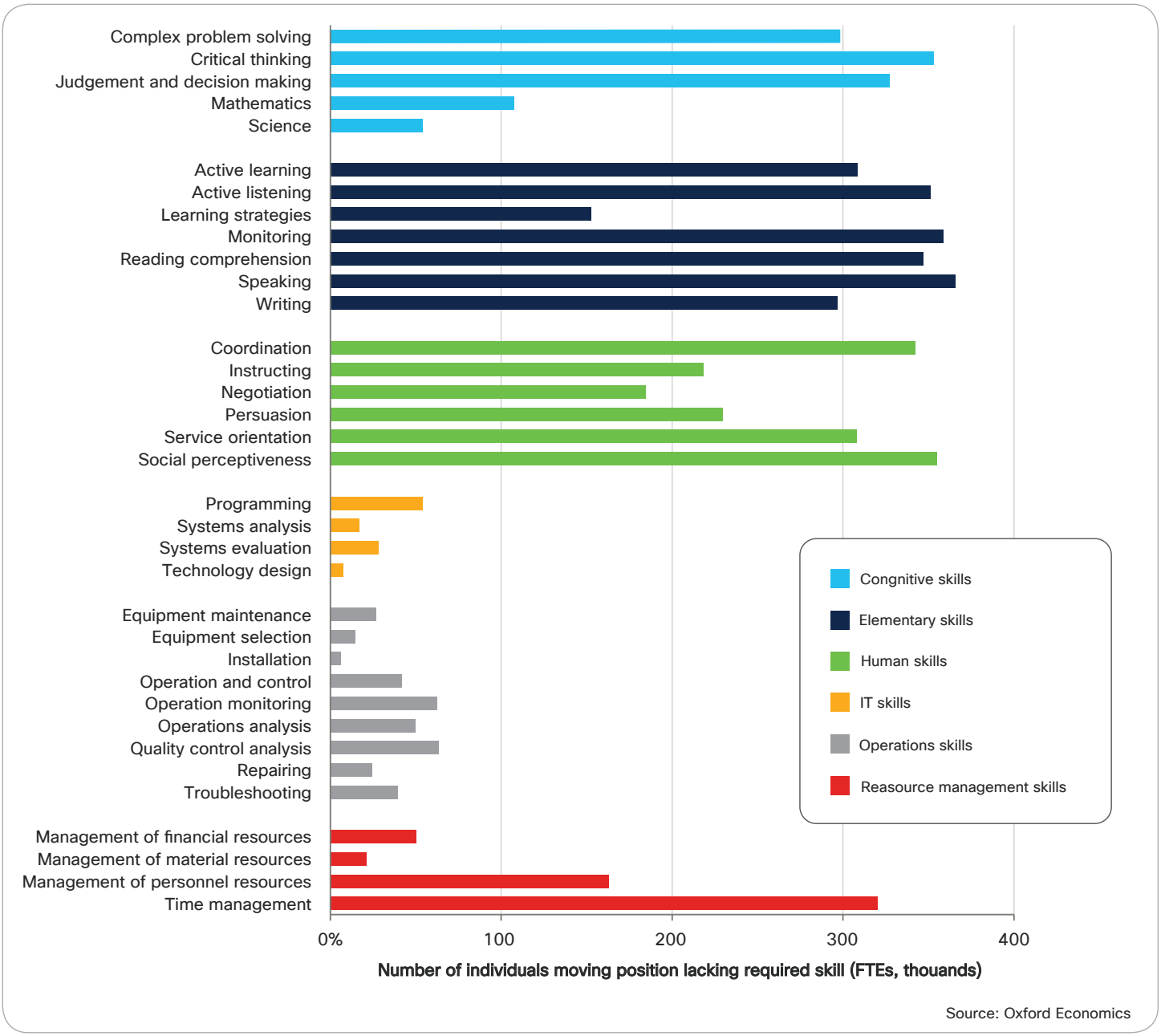
From the point of view of the numbers of workers affected, it is the softer human and elementary skills that pose the largest challenge for today's workforce. While the skills shortfall is typically narrower for this category – making the individual challenge typically less acute – the number of workers falling short of various softer skillsets is much greater.

A much larger share of future jobs will demand interactive, communication skills than they do today. While technological innovation is driving change, and many workers will be required to work more closely with technology, the biggest shift in employment levels in Australia will be into jobs requiring more of these softer skillsets.

Our model shows that more than 350,000 workers will find themselves moving into jobs that require an upgrade to such skills as active listening, speaking, and critical thinking skills. More than 150,000 will need to upgrade their ability to negotiate, persuade, and learn–functions that are much less important to their roles today.

This largescale softer reskilling requirement poses a very different challenge to stakeholders in the Australian labour market to the need for STEM skills training. The mode, method, and frequency of training will differ accordingly, which is a critical consideration for businesses, policymakers and educators in how they should prepare to provide the necessary skills training.

Figure 15. Number of individuals facing a skills gap

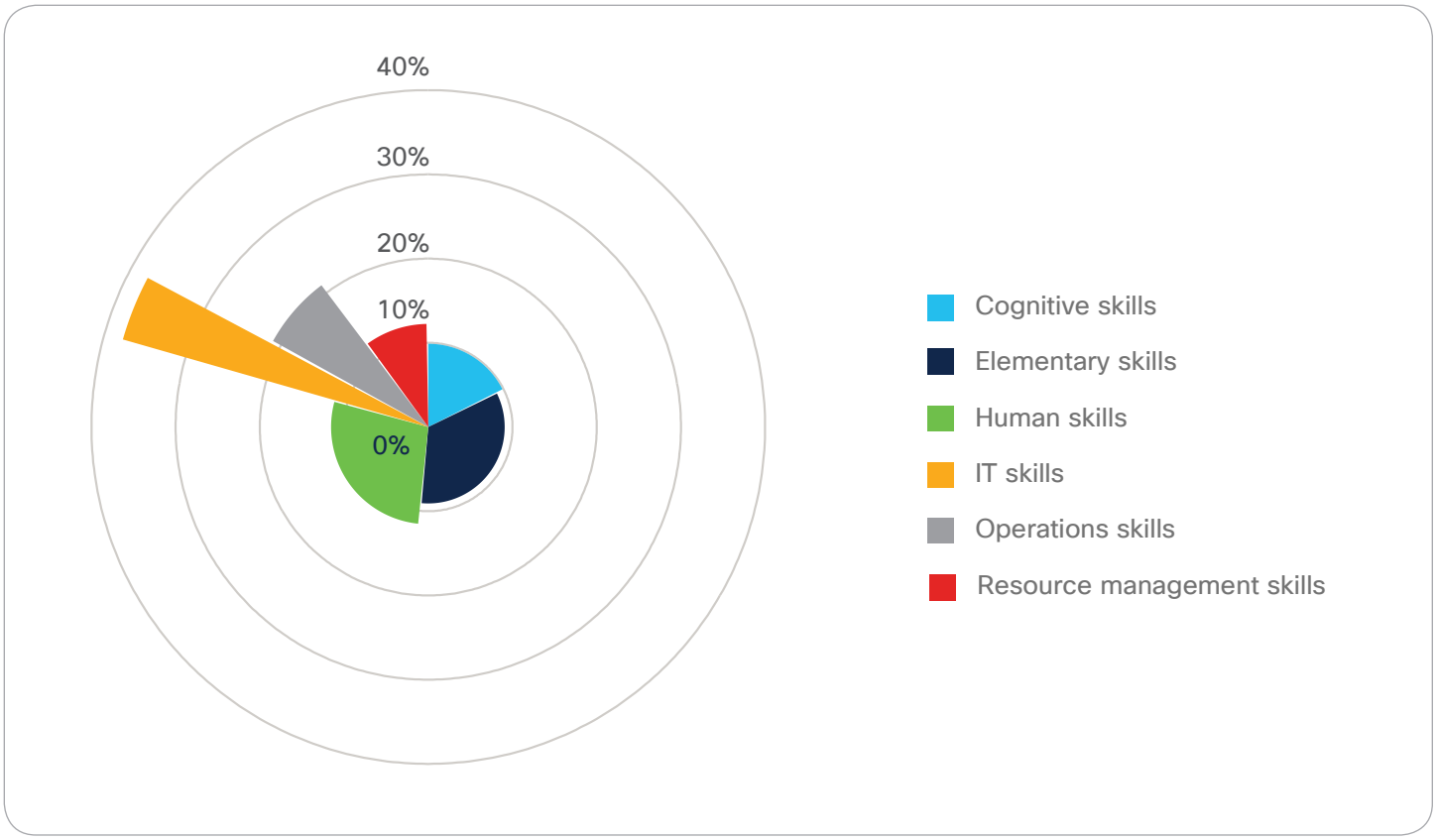


Source: Oxford Economics

Fig. 16 illustrates the relative acuteness and breadth of the skills challenges in each of our six overarching categories. The length of the segment represents the relative size (acuteness) of the skills shortfall for each category, while the angle represents its share of the total skills gap.

IT skills and operations skills protrude from the pie, emphasising the difficulty of preparing today's workers with such sophisticated skills. However, the largest share of the pie is taken up by elementary and human skills – categories that are characterised by relatively small skills shortfalls but on a vast scale. For this reason, the Australian economy has as much of a job to do in readying today's workers for these new demands as it has in training the next generation of STEM specialists.

Figure 16. Skills shortfalls for each overarching category, by both their relative breadth and acuteness



How will technology evolve the sector?

Agriculture

Cisco sector point of view

Australia's agriculture sector already faces significant challenges thanks to slim profit margins, inefficient supply chains and unpredictable weather, while poor connectivity has meant that until recently the sector has been unable to take advantage of many of the benefits of digitalisation. But as network issues begin to be resolved, the sector finds itself lagging other industries in terms of its capability to wield digital technology to boost its economic performance.

The challenge now is to quickly build up capabilities within the agriculture sector to utilise digital technologies such as connected sensors and data analytics to provide greater insights into farm performance and translate these into productivity benefits. Significant opportunities exist to boost farm performance by automating production and logistics processes, but only if the skills exist that enable appropriate solutions to be developed.

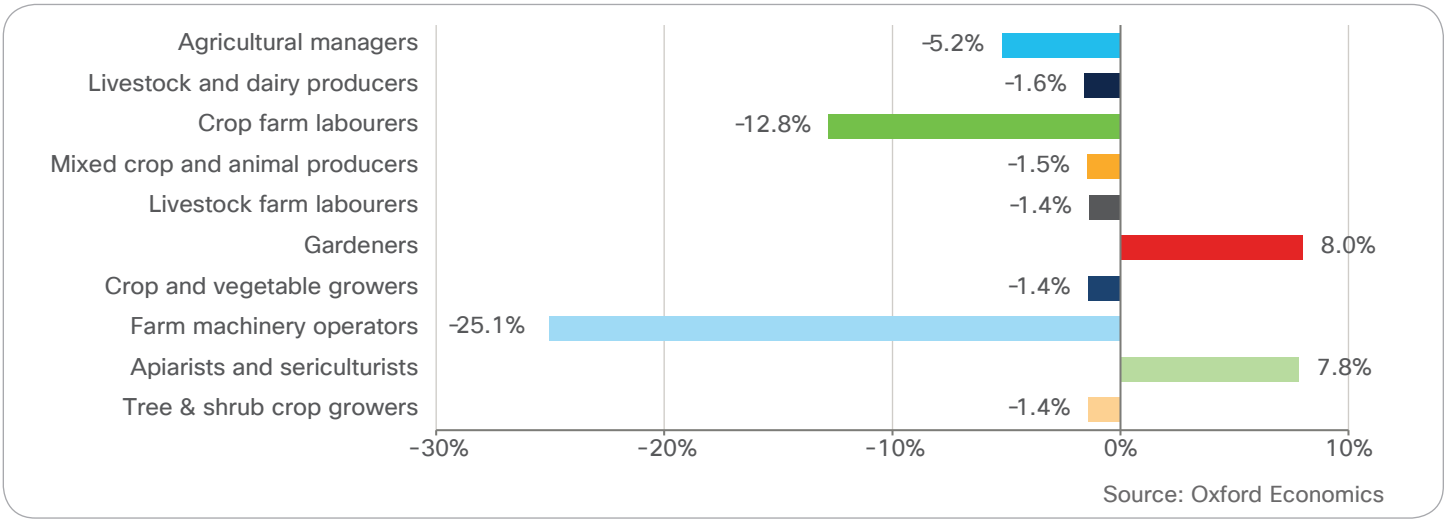
Almost 3% of today's Australia workforce is employed in the agriculture sector. Its task profiles are dominated by physical interactions and capturing and monitoring information, which means many of these workers will see change over the next 10 years.

How will the demand for agriculture workers evolve over the next decade?

Almost 3% of today's Australian workforce is employed in the agriculture sector. Its task profiles are dominated by **physical interactions and capturing and monitoring information**, which means many of these workers will be highly vulnerable to automation over the next 10 years.

Our analysis predicts a particular reduction in demand for **crop farm labourers and mobile farm plant operators,** falling 13% and 25% respectively. These jobs are highly vulnerable due to their routine and codifiable nature.

Figure 1. Net change in demand for 10 largest occupations in the agriculture sector (2018-2028)



In contrast, we predict the demand for **gardeners** to grow by 8%, as they benefit from productivity gains elsewhere. These workers spend relatively more time on less routine tasks such as **making human connections and thinking creatively**.

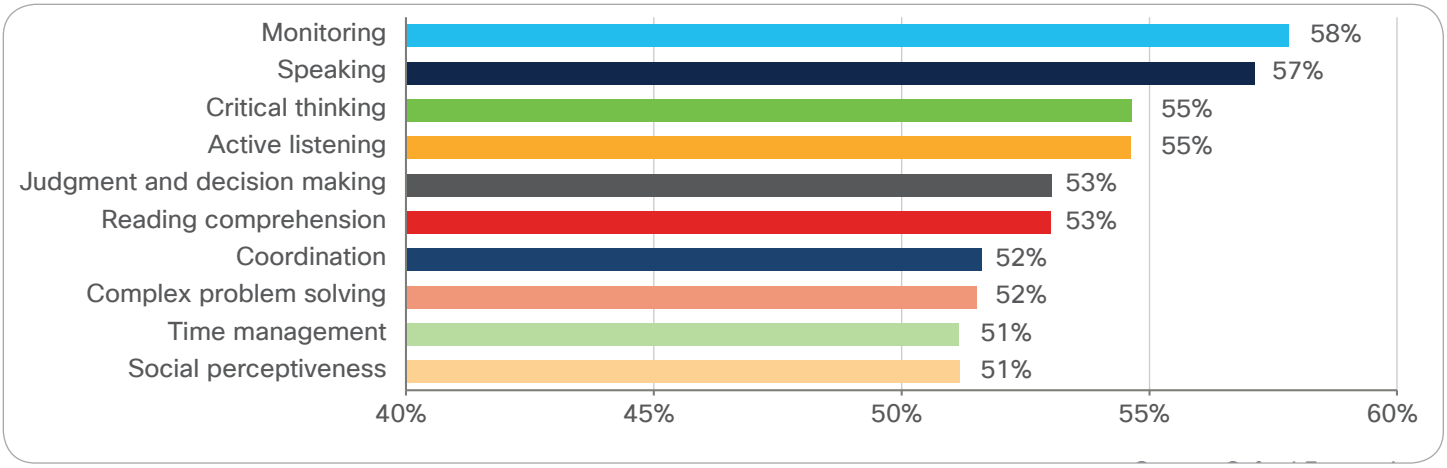
The future of jobs and skills needed

How widespread are skills shortfalls for new entrants to this sector?

As well as an overall reduction in headcount in agriculture, the rebalancing of demand for workers within the sector will lead to a significant reskilling challenge as new roles emerge.

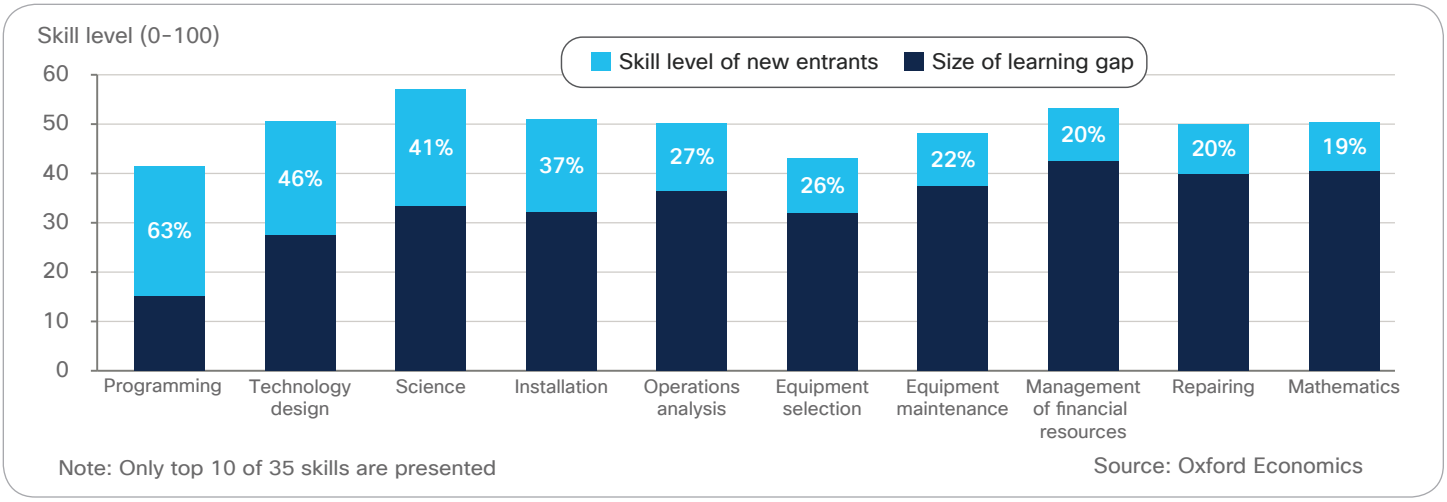
Our analysis suggests that more than half of the most likely talent pool to fill these vacancies (both from within and outside the sector) lacks some necessary skills, especially regarding **monitoring, speaking** and **critical thinking**. These skills are a core element of the available roles, meaning widespread retraining will be vital.

Figure 2. Proportion of new entrants into the agriculture sector facing a skills shortfall (top 10 skills)



In which skills do new entrants require the most training?

Figure 3. Top 10 acute skills shortfalls facing new entrants into the agriculture sector



For emerging jobs that require more technical skills such as **programming, technology design** and **science** skills, we see that the most likely prospective workers are significantly under skilled. While the numbers of workers required for these roles are relatively few, the task of finding suitable employees represents a significant challenge for the sector. In contrast, for the wider set of skill requirements we predict in the sector the reskilling gap is actually smaller than for most other sectors of the Australian economy.

How will technology evolve the sector?

Mining

Cisco sector point of view

Mining is a high-risk industry, both from an economic and a human cost perspective. For Australia's mining companies, the challenge is to reduce costs and enhance production while ensuring the safety of workers. Technology has proven to be a key tool for achieving both objectives through delivering remote operating capabilities, while also enabling the deployment of comprehensive sensing capabilities that are painting a clearer picture of mining operations, especially in terms of managing equipment maintenance and monitoring environmental impacts.

The challenge now is to continue to build a strong technology skills capability while strengthening capabilities in managing complex automated environments. Miners must also develop data analytics skills to ensure they are driving maximum efficiency from operations and maximising yields.

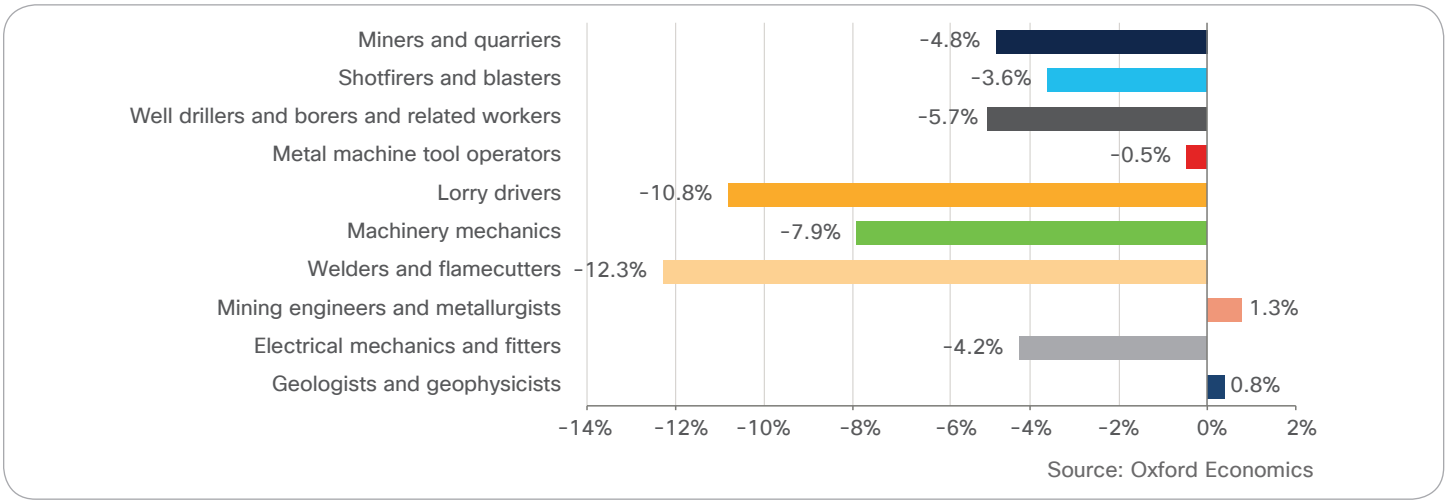
Although we predict a net decline in demand for mining sector workers overall, productivity gains will mean a reorganising of the workforce around the roles that continue to add value alongside advanced technology.

1.1. How will the demand for mining workers evolve over the next decade?

Today's mining workforce is highly vulnerable to the wave of technological change that is likely to occur over the next 10 years. Its vulnerability comes from the nature of the tasks workers typically perform in this sector. Work is geared heavily towards automatable tasks such as physical interactions, analysing routine data and capturing and monitoring information.

Our analysis projects a significant drop in demand for many of the highest employing occupations in the mining sector, particularly truck drivers and welders and flame cutters, whose numbers we predict to fall by more than 10% by 2028.

Figure 1. Net change in demand for 10 largest occupations in mining sector (2018-2028)



By comparison, occupations such as **mining engineers** and **geologists and geophysicists** are less vulnerable to automation. As new technology is integrated into business processes, the focus on critical and creative thinking in these roles means demand for these positions will rise over the coming decade.

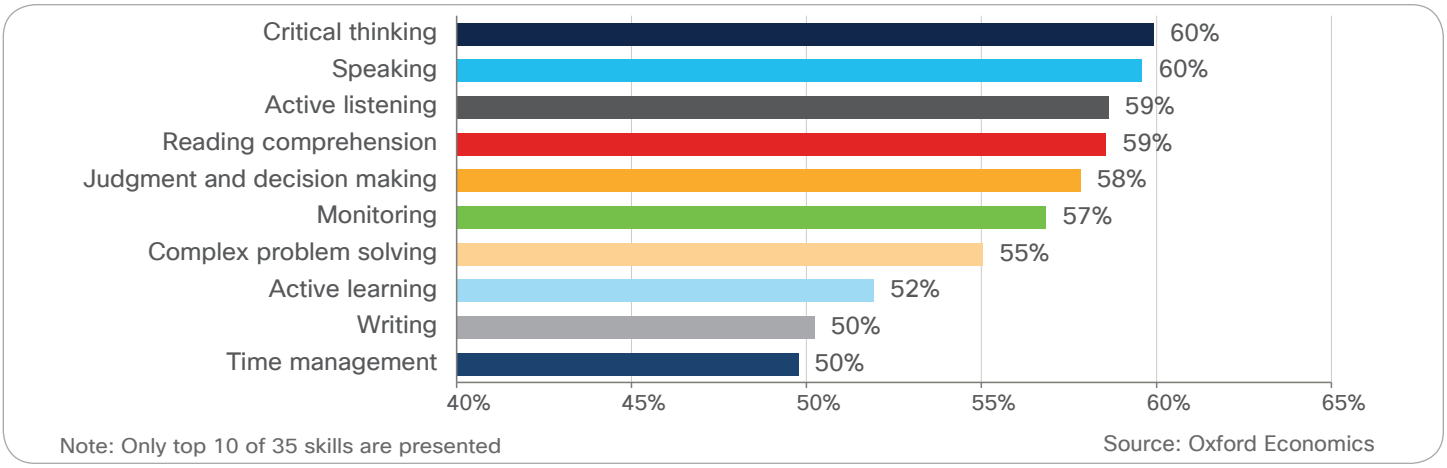
The future of jobs and skills needed

How widespread are skills shortfalls for new entrants to this sector?

Although we predict a net decline in demand for mining sector workers overall, productivity gains will mean a reorganising of the workforce around the roles that continue to add value alongside advanced technology.

That shift implies pervasive skills gaps to be overcome, chief among them are **critical thinking and speaking**. We found that 60% of the most likely talent pool were lacking in these skills. This sector is amongst the most exposed to the breadth of the reskilling challenge in terms of the proportion of vacancies with skills shortfalls.

Figure 2. Proportion of new entrants into the mining sector facing a skills shortfall (top 10 skills)

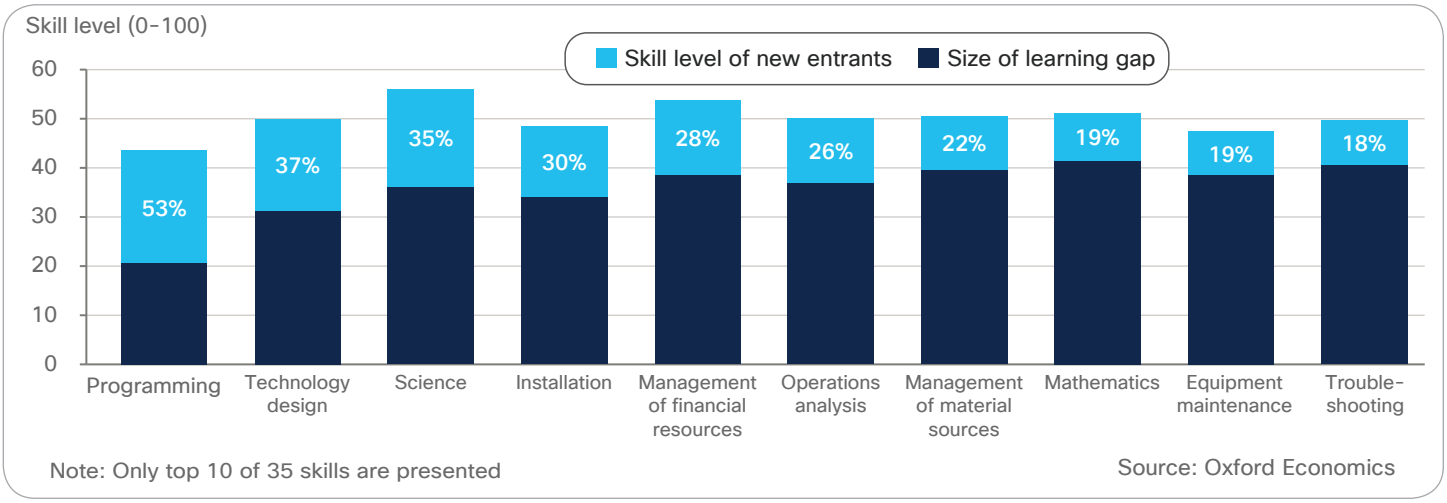


Note: Only top 10 of 35 skills are presented

Source: Oxford Economics

In which skills do new entrants require the most intensive training?

Figure 3. Top 10 acute skills shortfalls facing new entrants into the mining sector



Note: Only top 10 of 35 skills are presented

Source: Oxford Economics

The shift in demand for skills in the sector leaves significant shortfalls to bridge in some areas, but not all. In the most exposed occupations, the most likely talent pool to fill new positions requiring **programming** skills is 53% short of the level it requires, for **technology design** skills it is 37% short. But on the whole, the learning curve for skills demanded is less steep in the mining sector than for many other sectors in our study, meaning the available pool of workers are relatively well placed to adapt to new technologies.

How will technology evolve the sector?

Utilities

Cisco sector point of view

The convergence of operational and digital technology within Australia's utilities sector presents a significant skills challenge as operators seek to modernise systems and improve efficiency. The desire to better understand and control systems performance in real time has led to major programs of work using Internet of Things technology, which requires the blending of digital technology skills with traditional operational technology capabilities. Energy utilities specifically are also having to cater to the emergence of home solar generation within the grid.

The vast amounts of data that can be generated through IoT deployments is also fuelling demand for data analytics and science skills to create actionable insights, along with automation skills to improve responsiveness within the network. And the requirement for utilities companies to work together in smart cities initiatives is driving the need for greater collaboration and systems thinking skills.

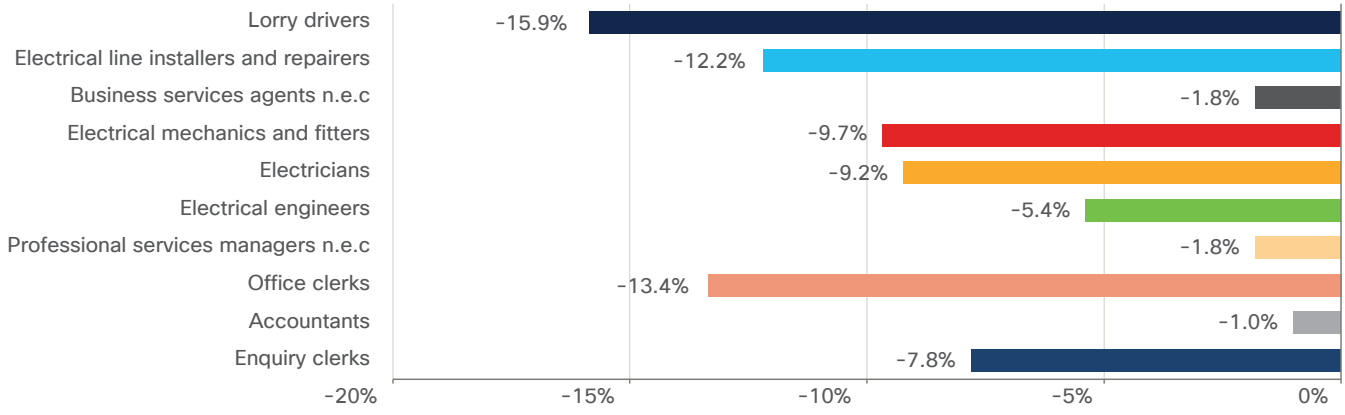
Based on the nature of work for the most common occupations, the workforce is ripe for technological disruption. Routine tasks, such as **analysing routine data**, are characteristic of many jobs, and innovations in AI and IoT will make it cost-effective to automate such functions.

How will the demand for utilities workers evolve over the next decade?

Based on the nature of work for the most common occupations in the utilities sector, the workforce is ripe for technological disruption. Routine tasks, such as **analysing routine data,** are characteristic of many jobs, and innovations in artificial intelligence and the internet of things will make it increasingly cost-effective to automate such functions.

We predict a fall in demand for workers across each of the top 10 most common occupations in the utilities sector, over the coming decade. Most notably, truck drivers are predicted to experience a 16% fall in demand and office clerks 13%.

Figure 1. Net change in demand for 10 largest occupations in the utilities sector (2018-2028)



Source: Oxford Economics

The task composition of these two roles differs but both are exposed to technological automation in different ways. The latter due to innovations in data capture, environmental monitoring and autonomous vehicles, the former due to the heavy role that routine administration and communication tasks play in the job.

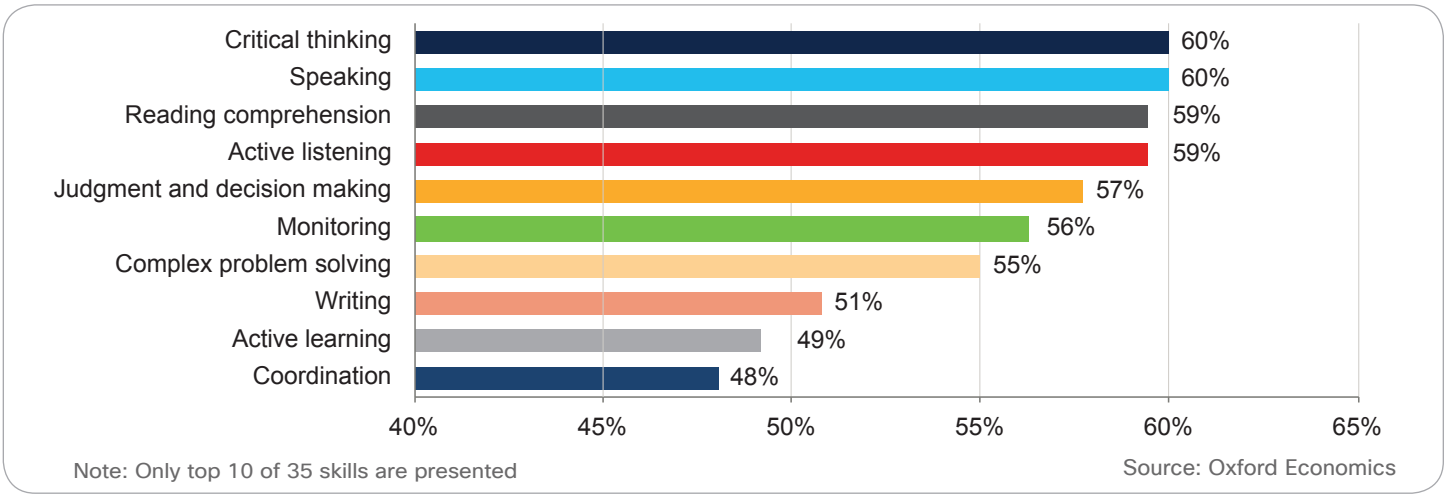
The future of jobs and the skills needed

How widespread are skills shortfalls for new entrants to this sector?

Despite the net contraction in the size of the workforce, we anticipate that as the demands on utilities workers evolve, new vacancies will also be created. Filling these roles will require employees from other parts of the economy overcoming pervasive skills shortfalls.

Our analysis suggests the most common shortfalls in the available talent pool are in skills such as monitoring and critical thinking. The scale of the challenge in the utilities sector is among the largest of all sectors in the Australian economy.

Figure 2. Proportion of new entrants into the utilities sector facing a skills shortfall (top 10 skills)

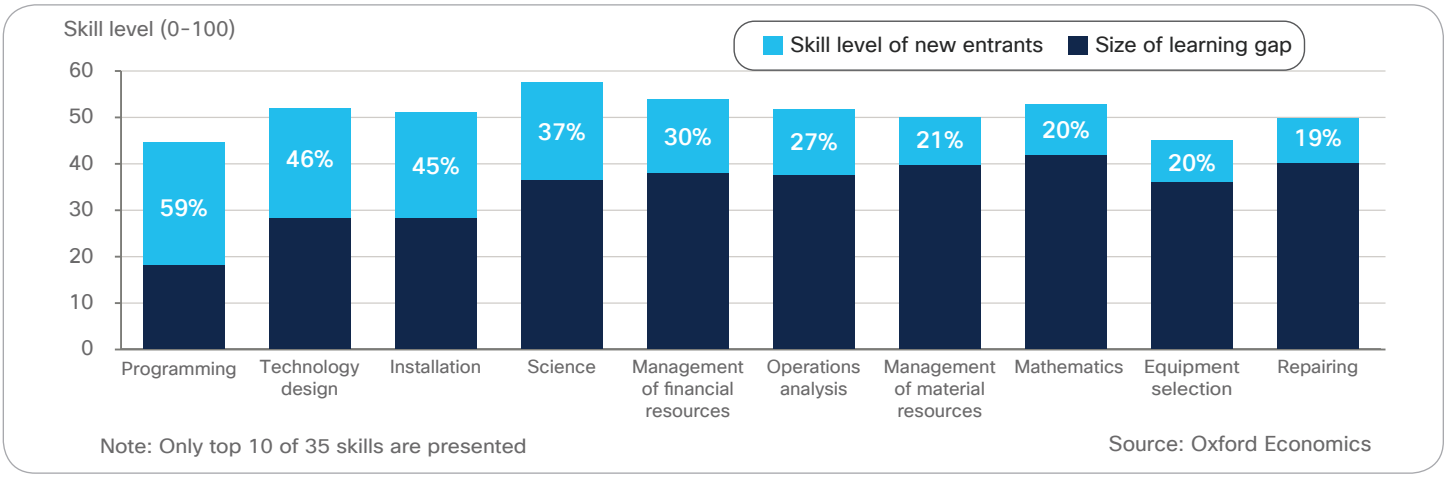


Note: Only top 10 of 35 skills are presented

Source: Oxford Economics

In which skills do new entrants require the most intensive training?

Figure 3. Top 10 acute skills shortfalls facing new entrants into the utilities sector



Note: Only top 10 of 35 skills are presented

Source: Oxford Economics

Our analysis suggests that **programming, technology design and installation skills** constitute the most acute skills shortfalls, given the existing capabilities of the available talent pool. We predict that, without action, new entrants to the utilities workforce will be 59%, 46% and 45% short of the required skill level, respectively. For other skills, the intensity of training required to prepare prospective workers is much smaller. The sector therefore faces a multi-faceted skills challenge comprising concentrated but acute skills gaps as well as widespread but shallow skills gaps.

How will technology evolve the sector?

Wholesale and Retail

Cisco sector point of view

The rapid uptake of ecommerce services within Australia is placing pressure on all retailers to improve customer experience and overall service levels, with particular emphasis on greater personalisation. This is creating significant requirements for skills in digital systems design, programming, data analytics and artificial intelligence to improve services and enable retailers to be more responsive to customer needs.

Increasing competition is also driving the need for service improvement in the offline world, fuelling demand for improved interpersonal skills on the shop floor. At the same time, the need to reduce margins without diminishing service levels is pushing the requirement for skills in systems process redesign and technology driven automation, especially in warehousing and logistics roles, as employees are moved away from low-value roles.

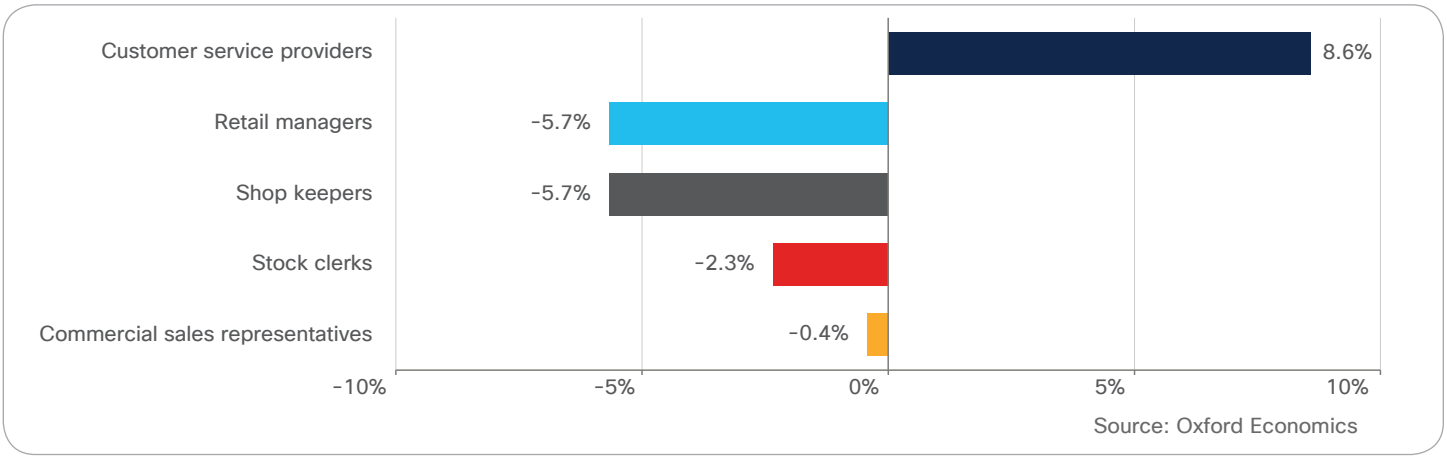
As the sector becomes increasingly digitised, it is significantly under skilled in technical skills such as programming, science and technology design

How will the demand for wholesale and retail workers change over the next decade?

The wholesale and retail sector is a major employer, with more than one million workers in 2018. It incorporates a diverse range of occupations.

Many are characterised by tasks that are highly vulnerable to automation, such as routine communication with colleagues and customers. But many occupations in the sector demand less automatable tasks, such as making human connections and interacting with computers. Over the next decade, we expect a rise in consumer spending to offset the automation effect on jobs in this sector.

Figure 1. Net change in demand for the largest occupations in wholesale and retail sector (2018-2028)



Source: Oxford Economics

We predict over 8% growth in demand for customer service providers – a larger category that includes positions such as **shop sales assistants** and **beauticians**. This is because the increase in demand for the services they provide outweighs the jobs impact of the productivity improvements technology will bring. These and other jobs in this sector will evolve around technology to focus more heavily on less automatable tasks, such as resolving conflicts, assisting others and thinking creatively as well as digital tasks such as interacting with computers. We predict that other occupations, such as **retail managers** and **stock clerks** will experience a net reduction.

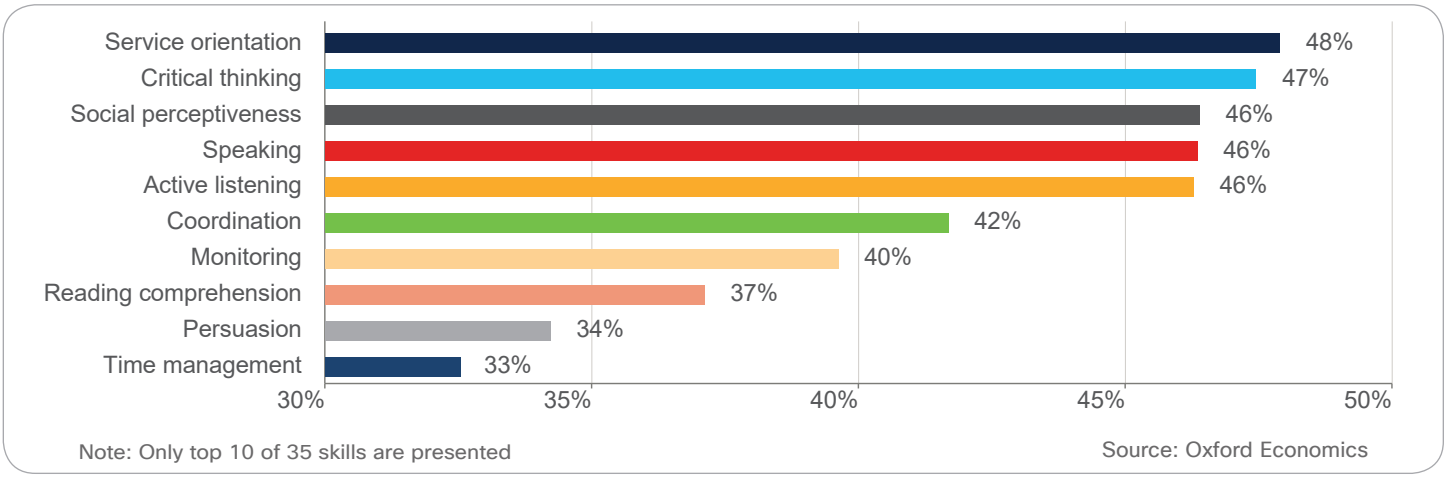
The future of jobs and skills needed

How widespread are skills shortfalls for new entrants to this sector?

The predicted net growth in demand for workers in this sector will require candidates to be drawn in from across the wider workforce. Our analysis suggests the talent pool likely to fill this gap is short of the appropriate skills.

We predict just under half the workers most likely to fill these roles will need to materially upgrade their **service orientation** and **critical thinking skills**, amongst others. However, the nature of work and the structure of the labour market means the breadth of the reskilling challenge is less impactful than for most other sectors.

Figure 2. Proportion of new entrants into the wholesale and retail sector facing a skills shortfall (top 10 skills)

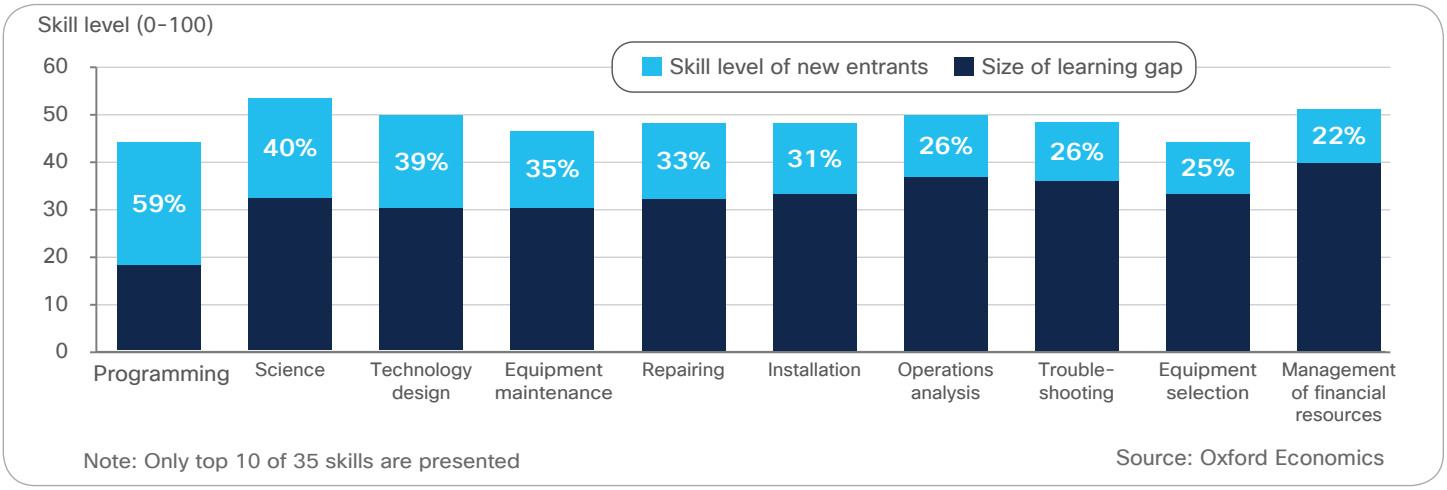


Note: Only top 10 of 35 skills are presented

Source: Oxford Economics

In which skills do new entrants require the most intensive training?

Figure 3. Top 10 acute skills shortfalls facing new entrants into the wholesale and retail sector



Note: Only top 10 of 35 skills are presented

Source: Oxford Economics

Our analysis suggests that, in a sector becoming increasingly digitalised, there is an insufficient supply of technical skills in the available talent pool. In particular, prospective workers are significantly under skilled in **programming** skills, falling 59% short of the required skill proficiency. Science and technology design skills represent the next two most acute reskilling challenges. Although the acute skills challenges in Fig. 3 refer to a small subset of the workforce, their size and importance pose a significant challenge.

How will technology evolve the sector?

Transport

Cisco sector point of view

Growing urban congestion and the urgent need to improve safety present significant challenges for Australia's transport sector. Technology-based solutions such as intelligent transport networks are creating demand for skills for the deployment and operation of Internet-of-Things style sensors and control devices, often requiring merged abilities across digital networks and operational technology. These developments will also require systems thinking skills in order to weave the data they generate into efficient solutions.

The transport sector faces another skills challenge with the arrival of autonomous vehicles and mobility-as-a-service offerings. These have the potential to displace a significant numbers of workers, while also driving demand for systems management skills for the design and operation of increasingly complex networks of connected devices and vehicles.

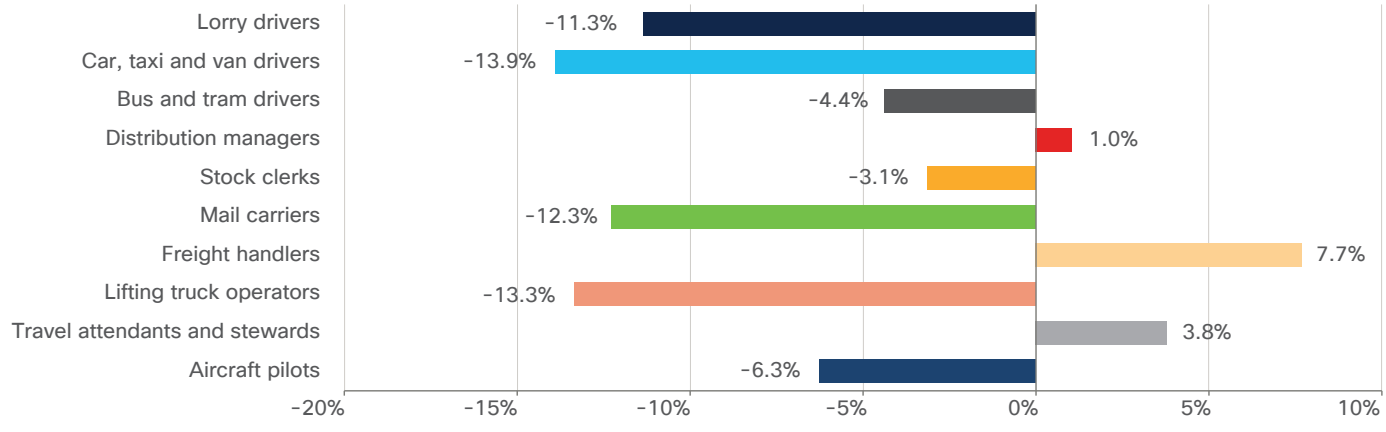
In the next decade, we envisage the technology landscape will have great leaps forward in autonomous vehicles. New positions will also emerge in the sector as the workforce adapts to the new technologies available.

How will the demand for transport and storage workers evolve over the next decade?

The 10 year technology landscape upon which our modelling assumptions are based envisages great leaps forward in autonomous vehicles. We predict an 11.3% reduction in lorry drivers, and an almost 14% reduction in car, taxi and van drivers, under this scenario.

But drivers do not represent the whole of the transport and storage sector workforce. Technological innovation will also leave other workers, such as stock clerks and mail carriers, vulnerable to change. Their roles are characterised by routine and predictable work, that robots can increasingly perform well and cost-effectively.

Figure 1. Net change in demand for 10 largest occupations in the transport and storage sector (2018-2028)



Source: Oxford Economics

We see **travel attendants,** by comparison, as far less vulnerable to automation, thanks to the relatively higher importance of more cognitive, unpredictable functions they perform, including making human connections and thinking creatively. Our analysis suggests a 4% growth in demand for travel attendants and stewards by 2028.

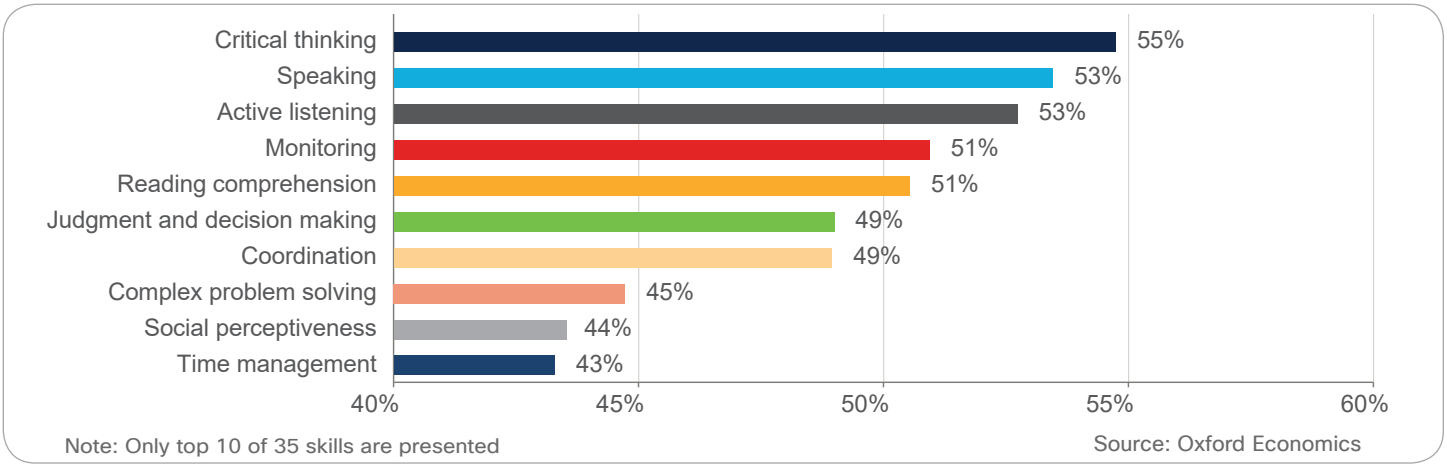
The future of jobs and the skills needed

How widespread are skills shortfalls for new entrants to this sector?

With largescale technological disruption, the makeup of the transport and storage sector workforce will change markedly over the next decade. Many workers will be made redundant, but new positions will also emerge in the sector as the workforce adapts to the new technologies available.

We predict a widespread reskilling effort will be needed to meet that challenge, in particular in **critical thinking, speaking and active listening**. More than 50% of the available talent pool entering jobs in the sector would require upskilling in these skills.

Figure 2. Proportion of new entrants into the transport and storage sector facing a skills shortfall (top 10 skills)

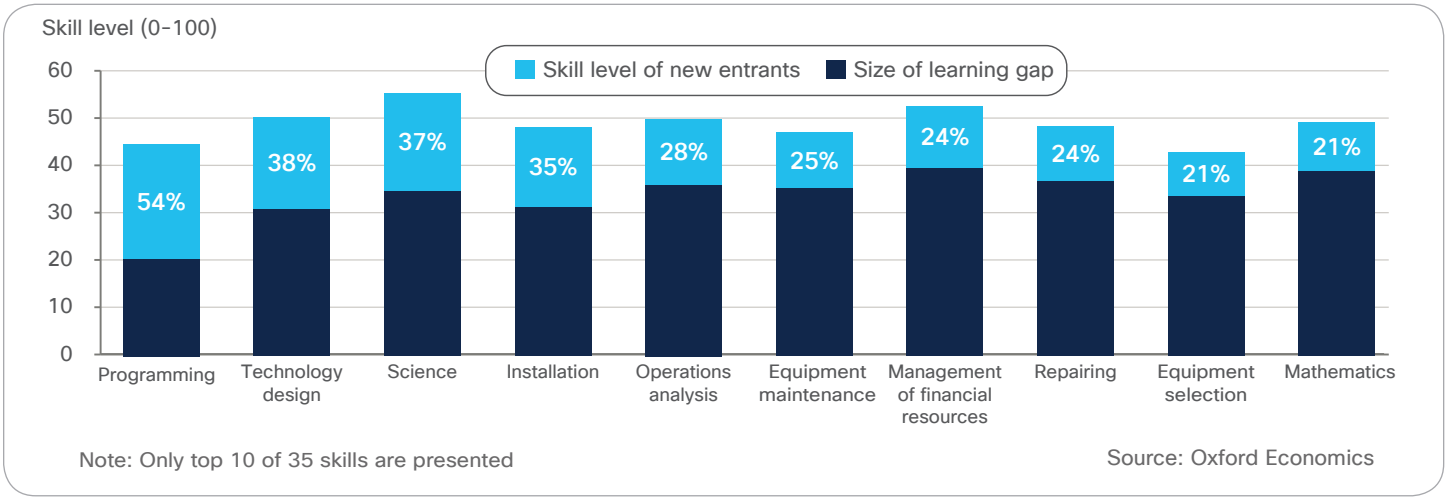


Note: Only top 10 of 35 skills are presented

Source: Oxford Economics

In which skills do new entrants require the most intensive training?

Figure 3. Top 10 acute skills shortfalls facing new entrants into the transport and storage sector



Note: Only top 10 of 35 skills are presented

Source: Oxford Economics

Looking across the spectrum of skills required in the 2028 transport and storage sector workforce, prospective workers face a steep learning curve in technical skills. Most prominently is **programming** skills, for which the available talent pool falls 54% short of the required level. By contrast, the most widespread reskilling challenges highlighted in Fig. 2 are typically characterised by a much smaller learning gap.

How will technology evolve the sector?

Finance

Cisco sector point of view

The finance sector's insatiable need for technology skills shows no signs of slowing down as companies strive to increase their capabilities in fields such as data analytics and artificial intelligence. But while technology has traditionally worked to support operations, many of these companies have become technology companies in their own right. This can be seen both in the transformation taking place within traditional providers and in the emerging crop of fin-techs and neo-banks.

This focus on technology does not however come at the expense of human interaction. Finance sector companies are placing greater emphasis on improving employee engagement and customer service, and we will see more investments in automation, analytics and customer interaction technology to empower employees accordingly. It is expected they will continue to invest in security, governance and ethics, to ensure they can meet their compliance requirements and customers' expectations.

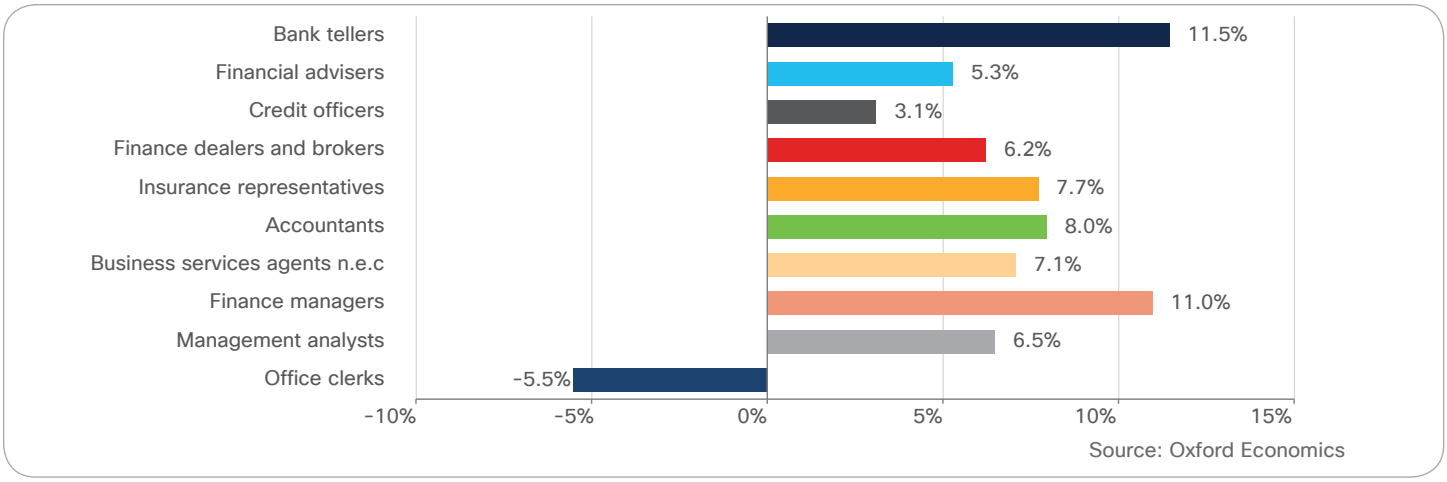
Finance sector companies are placing greater emphasis on improving employee engagement and customer service, and we will see more investments in automation, analytics and customer interaction technology to empower employees accordingly.

How will the demand for finance workers evolve over the next decade?

We forecast employment growth in the financial services sector under our 2028 scenario. For many occupations in this sector, the need for non-routine, interpersonal and cognitive tasks such as **interpreting information** for others and **providing advice** are valuable, and more difficult to automate. That means they are relatively well protected from the implications of the next decade's technological change.

An exception to that rule, amongst the sector's major occupations, is for office clerks. This role is typically focused on routine processing of information and **analysis of data**, tasks that technology is increasingly capable of performing. We predict a 5% drop in headcount for this position.

Figure 1. Net change in demand for 10 largest occupations in the finance sector (2018-2028)



Source: Oxford Economics

On the contrary, demand for **finance managers** and **bank tellers** (or an evolved variant of that customer-facing role) are predicted to grow by over 10%, as the importance of interpersonal tasks, such as customer orientation and conflict resolution, and cognitive tasks, such as interpreting information for others – at which workers in these roles excel, grow in a more technology driven environment.

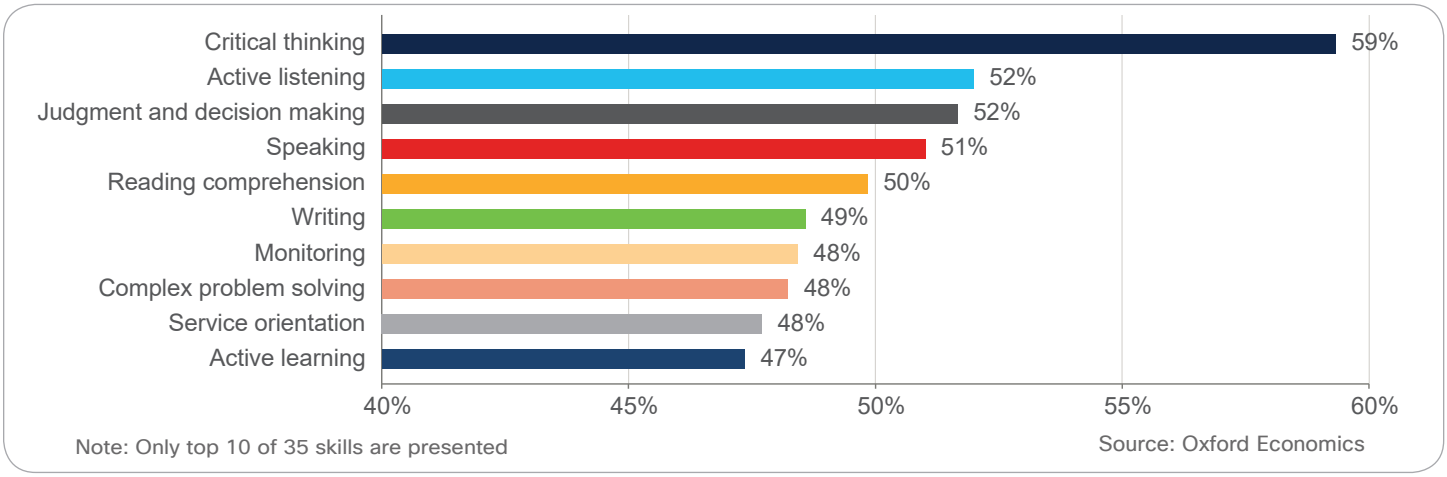
The future of jobs and skills needed

How widespread are skills shortfalls for new entrants to this sector?

An expanding finance sector will draw talent from other parts of the labour market but filling the new roles will require a degree of skills training. Our analysis suggests the most common skills challenge facing the available talent pool is in critical thinking. Almost 6 out of every 10 workers in the available talent pool lacks the necessary **critical thinking** skills for emerging jobs in the sector.

Training also needs to be prioritised in skills, such as **active listening** and **decision making**, for which the required level is lacking in more than half of the available talent pool.

Figure 2. Proportion of new entrants into the finance sector facing a skills shortfall (top 10 skills)

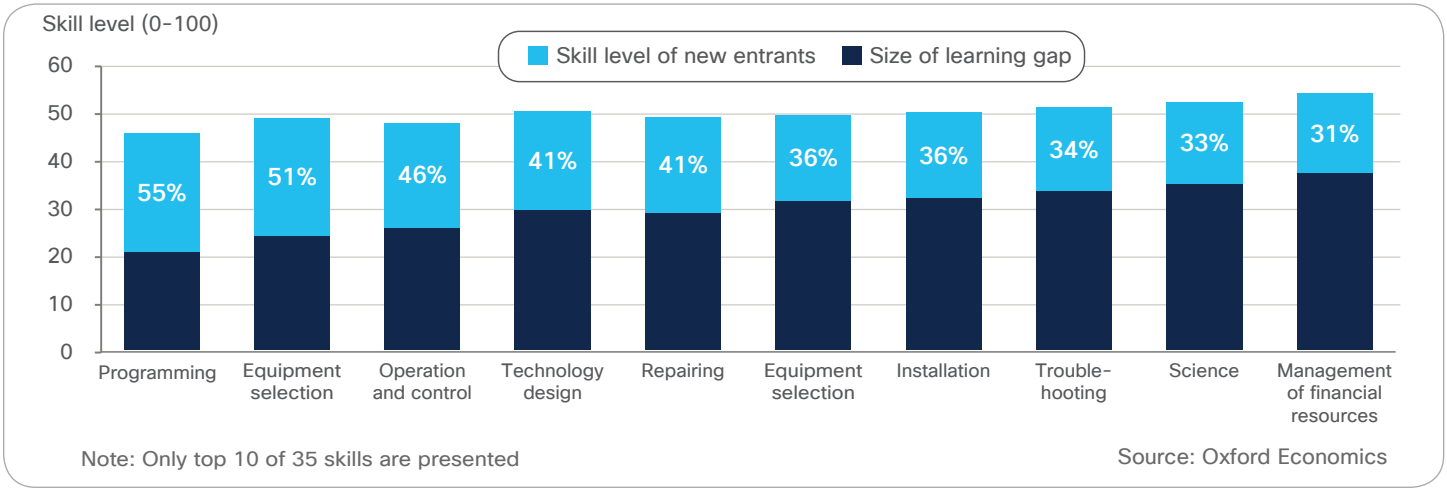


Note: Only top 10 of 35 skills are presented

Source: Oxford Economics

In which skills do new entrants require the most training?

Figure 3. Top 10 acute skills shortfalls facing new entrants into the finance sector



Note: Only top 10 of 35 skills are presented

Source: Oxford Economics

Our analysis also illustrates the acuteness of the skills shortfall across a range of skills. New entrants to the sector face a steeper learning curve than any other sector in Australia, given the relatively high demand for highly skilled professionals. Our analysis suggests that the most intense reskilling effort emerges in jobs requiring **programming skills**, for which the available talent pool is around 55% short of the level required. A significant uplift is also required in **equipment maintenance and operation and control** skills.

How will technology evolve the sector?

Education

Cisco sector point of view

Australia's educators face challenges on multiple fronts as new technologies and trends in learning impact a sector already struggling to meet the needs of Australia's rapidly growing population. Existing shortages of specialist teaching skills in fields such as STEM (science, technology, engineering and mathematics) will drive adoption of technology-based teaching methods to improve delivery of these subjects and ensure students in regional areas have access to the same opportunities.

Technology will also play a key role in changing education delivery at all levels from K12 through to vocational learning and higher education thanks to the uptake of virtual reality and augmented reality as learning aids in the classroom, while online technologies will continue to blur the boundaries between the classroom, playground and home. Educators at all levels will need to adapt to new teaching methods using these technologies including the greater usage of eLearning and micro-credentialing, especially the support of rapid skills development and life-long learning programmes.

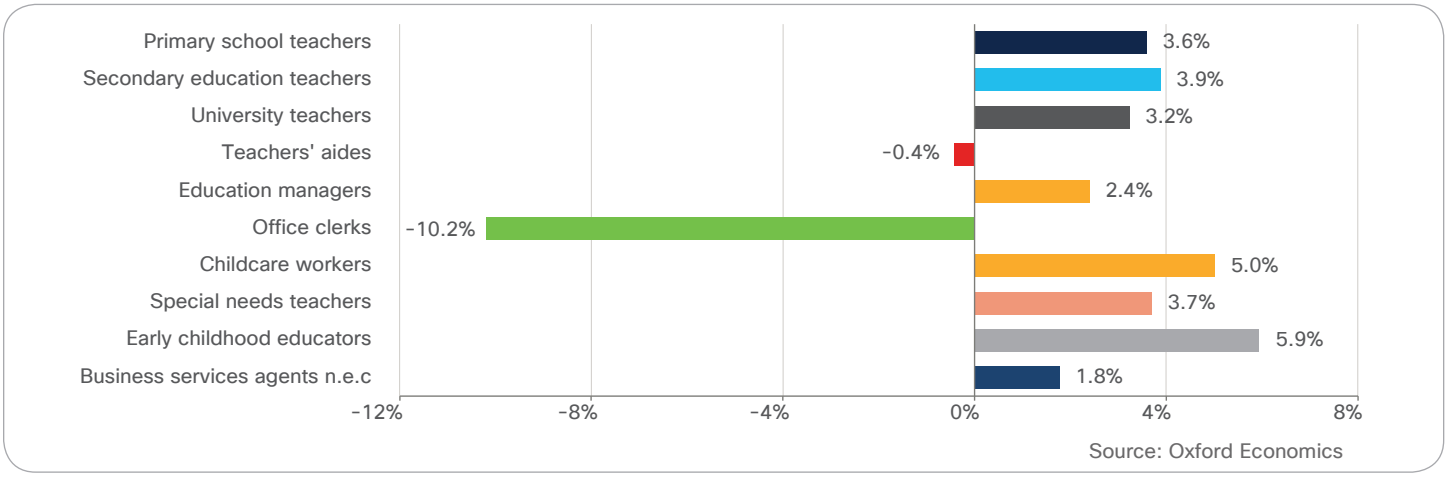
Our 2028 scenario suggests demand for education will grow in Australia, and therefore this sector will need to pull in workers from other parts of the labour market.

How will the demand for education workers evolve over the next decade?

Teaching professionals are the dominant occupational group in the education sector and, today, these roles rely heavily on nuanced tasks such as **establishing relationships, thinking creatively and guiding or motivating others**. These types of roles are less susceptible to automation over the coming 10 years.

However, many other occupations in this sector are more susceptible to technological change. Our analysis suggests the large body of office clerks in the sector could shrink by 10% over the next decade because they are relied upon to perform more readily codifiable functions.

Figure 1. Net change in demand for 10 largest occupations in the education sector (2018-2028)



In our technology scenario, we predict overall growth in jobs in the education sector, with over 5% growth in demand for **early childhood educators** and **childcare workers**. Core functions of these roles, including caring for others, building teams and resolving conflict, will continue to be performed most effectively by humans over the coming decade.

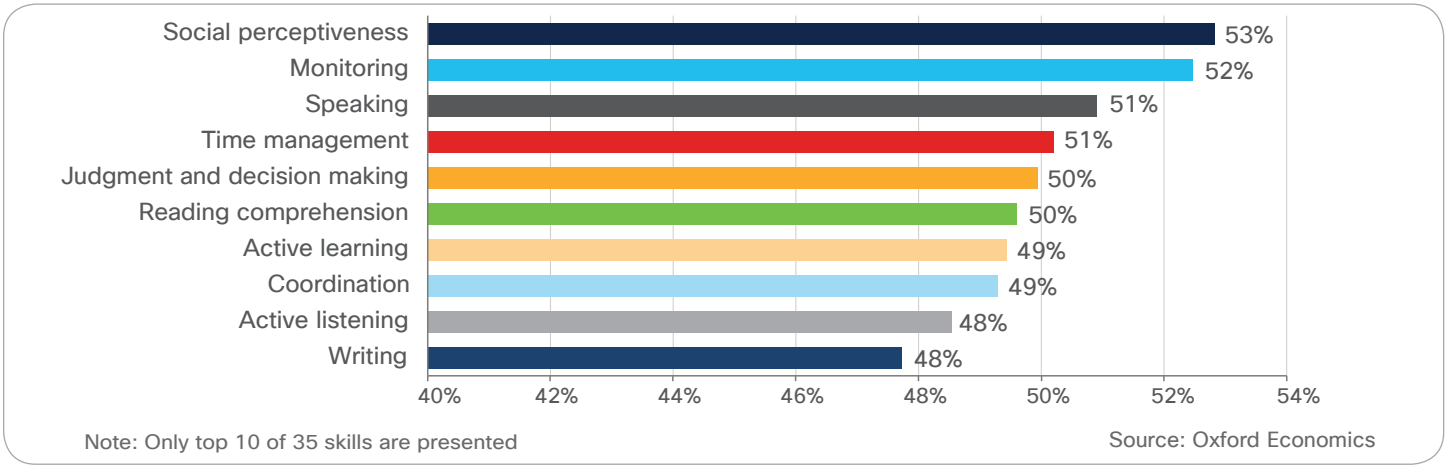
The future of jobs and skills needed

How widespread are skills shortfalls for new entrants to this sector?

Our 2028 scenario suggests demand for education will grow in Australia, and therefore this sector will need to pull in workers from other parts of the labour market.

Our analysis suggests that the most pervasive skills training priorities are in skills such as **social perceptiveness, time management and decision making**. More than half of the available talent pool to fill jobs in the sector currently lack these necessary skills.

Figure 2. Proportion of new entrants into the education sector facing a skills shortfall (top 10 skills)

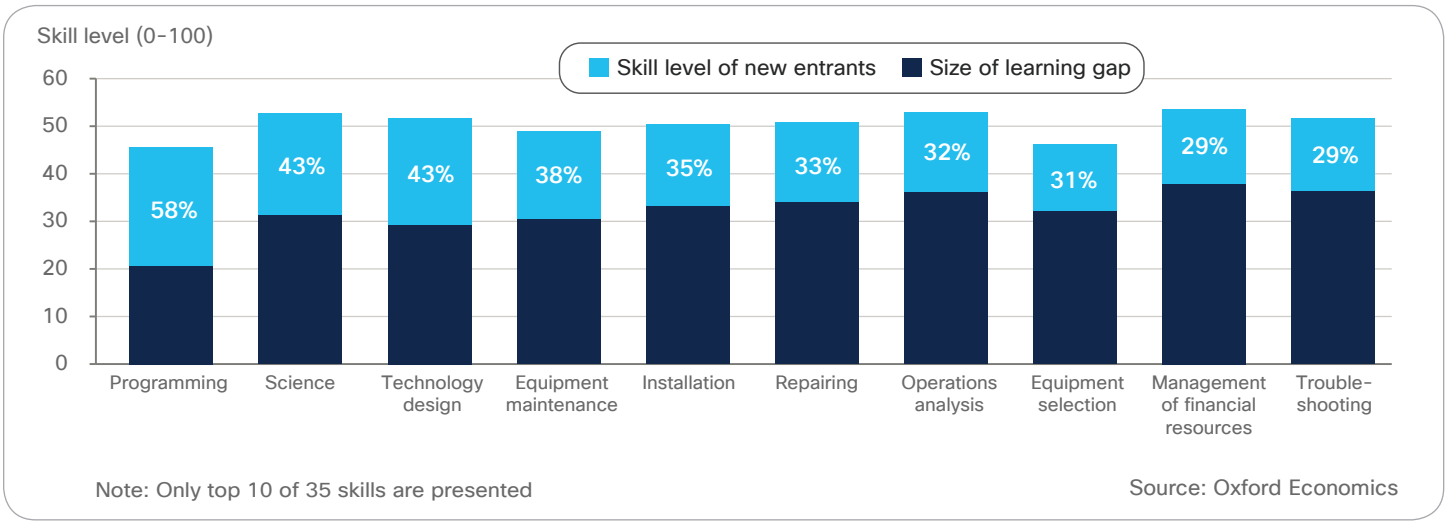


Note: Only top 10 of 35 skills are presented

Source: Oxford Economics

In which skills do new entrants require most intensive training?

Figure 3. Top 10 acute skills shortfalls facing new entrants into the education sector



Note: Only top 10 of 35 skills are presented

Source: Oxford Economics

The chart above illustrates the size of the learning curve the available talent pool would face to fill vacancies in this sector, across the most critical skills categories. Most prominently, those workers best placed to fill jobs requiring **programming skills** in this sector currently fall 58% short of the level they need. In **science** and **technology design** skills, the available talent pool falls more than 40% short.

How will technology evolve the sector?

Healthcare

Cisco sector point of view

Australia's healthcare sector is entering a period of unprecedented change thanks to the twin drivers of greater digitisation and rising customer expectations, coupled with an ageing population. The rapid introduction of technology for clinical care and patient management is creating immediate requirements for stronger digital skills across the workforce, particularly in relation to interaction with electronic health records. The massive volumes of data now being generated by the sector is also placing specific emphasis on the need for data analytics skills.

Concurrently the emergence of person-centric healthcare models is lifting requirements for soft skills within the sector, including human-centered design skills for service creation. There is also an emphasis on skills relating to patient care and customer service to become the interface between technology and the patient.

Australia's healthcare sector will be the biggest net job creator over the next decade, entering a period of unprecedented change thanks to the twin drivers of greater digitisation and rising customer expectations, coupled with an ageing population.

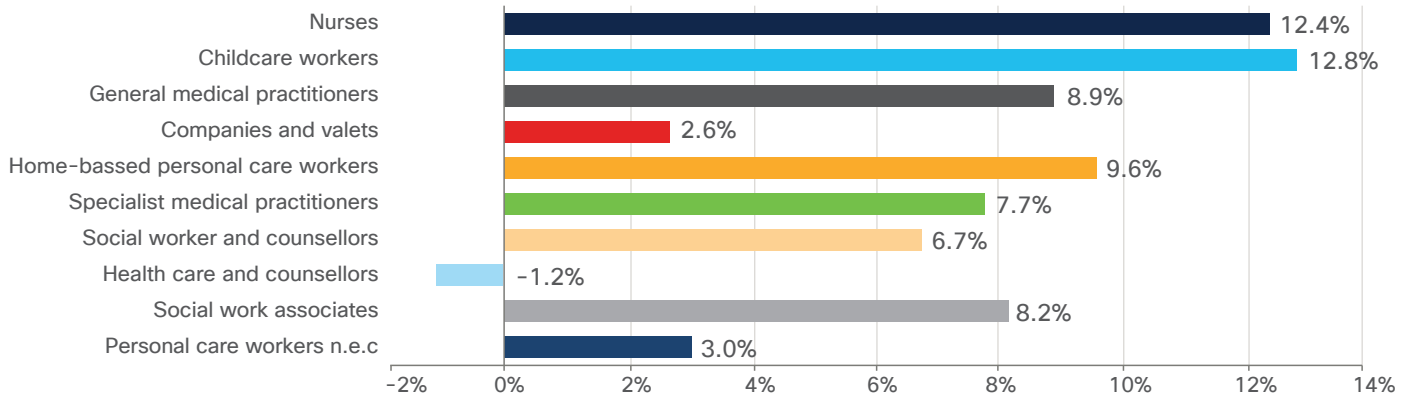
How will the demand for healthcare workers evolve over the next decade?

We predict that the growth in demand for workers in healthcare will outpace all other sectors of the Australian economy over the next 10 years. This in part reflects demographic trends, such as an ageing population, but also the sector's relatively low exposure to technological automation.

Performing important tasks, such as **assisting and caring** and **interpreting information for others**, will most likely remain in the domain of human workers over this time horizon.

Our analysis suggests demand for **nurses** and **childcare workers** will grow by over 12%, with **social care professionals** and **general medical practitioners** also set to grow by more than 8%.

Figure 1. Net change in demand for 10 largest occupations in healthcare sector (2018-2028)



Note: Only top 10 of 35 skills are presented

Source: Oxford Economics

We expect certain occupations to buck the trend and contract, such as **health care assistants.** This is because the specific nature of their role provides greater scope for automation, with a greater weight placed on tasks such as **routine administration and capturing and monitoring information**.

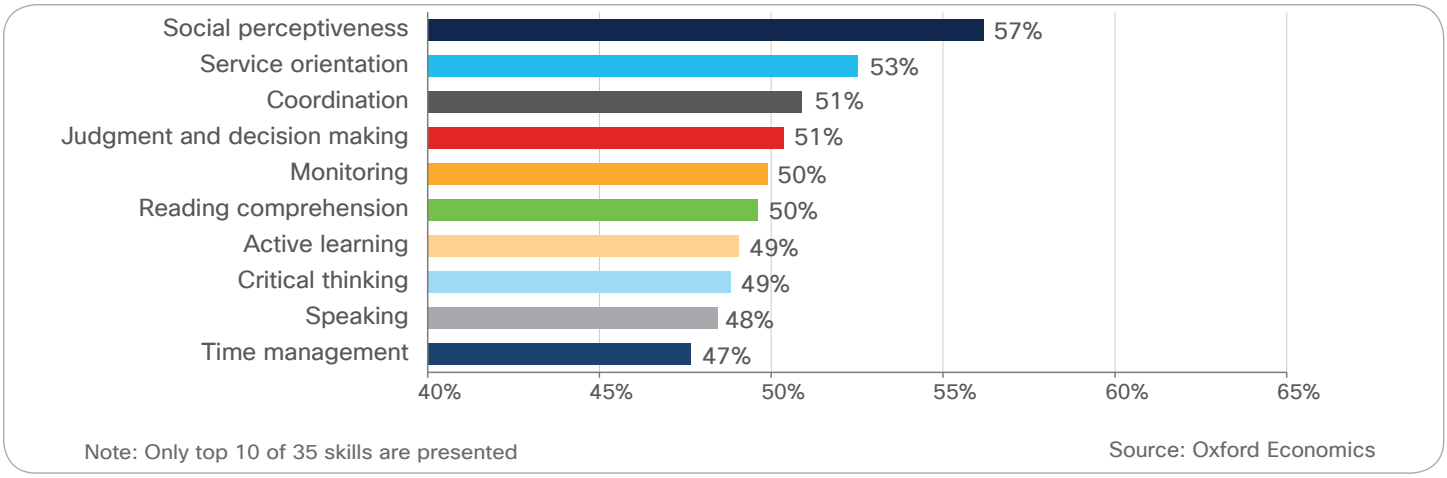
The future of jobs and skills needed

How widespread are skills shortfalls for new entrants to this sector?

Over the next decade, workers will be drawn in from other parts of the economy to meet the rising demand of healthcare. Each entrant will bring their own experience and skillset but will often need to reskill to succeed in their new role.

Our analysis suggests it is **social perceptiveness, service orientation** and **coordination**, that will most commonly be lacking. These are important skillsets in the sector and more than half of the available talent pool falls short of the required level of skills to fill the emerging vacancies.

Figure 2. Proportion of new entrants into the healthcare sector facing a skills shortfall (top 10 skills)

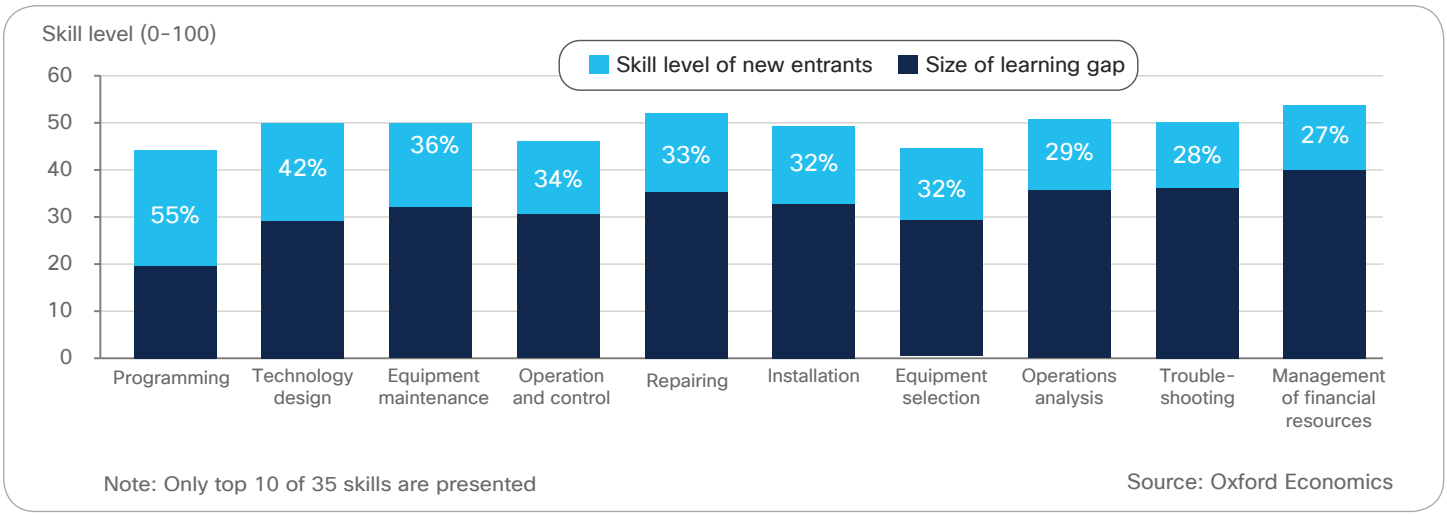


Note: Only top 10 of 35 skills are presented

Source: Oxford Economics

In which skills do new entrants require the most intensive training?

Figure 3. Top 10 acute skills shortfalls facing new entrants into the healthcare sector



Note: Only top 10 of 35 skills are presented

Source: Oxford Economics

In the healthcare sector, the reskilling effort will be most acute for **programming** and **technology design** with new entrants to roles demanding those skills falling 55% and 42% short of the required level, respectively. For the skills requiring widespread training provision, mentioned above, the learning gaps to bridge are relatively shallow compared to these more technical skills. This is because most candidates that will apply for vacancies in healthcare will come from similar sectors and professions, and will therefore bring with them highly relevant experience.

Reflections for the future

This unique collaboration between Oxford Economics and Cisco Australia reveals the far-reaching implications of technological change for the Australian labour market. Not a single occupation will be unaffected.

Workers will spend less time and effort on routine, predictable functions, and more on those tasks that are less codifiable – or at least less economical to automate at scale – in the parts of the economy that are experiencing growing demand. The result is a reshaping of the workforce across occupations and industries. Our analysis reveals the extent to which today's labour market falls short of the needs of the future economy, not only in technical skills, but also in softer skills where human workers will maintain a lasting competitive advantage.

The responsibility for preparing the Australian workforce for the future falls to multiple stakeholders: from policymakers to educators, business leaders and workers themselves. A failure to prepare them adequately will constrain the Australian economy's in its ability to capitalise on the opportunities that new technology can bring.

Below we summarise the challenges that each key stakeholder group will face.

Policymakers

- For policymakers, technology's impact on the labour market poses a dilemma. In a competitive global economy, it is paramount that Australia maintains an environment in which new technologies can thrive. On the other hand, the faster the rate of change, the greater the disruption imposed on the workforce, and the steeper the challenge for workers and businesses to reskill and adapt.
- For some workers, the shift implied by our scenario will imply wrenching change. Those whose occupations are in declining demand will have to adapt not only their skillsets, but potentially other aspects of their lives too, such as their working hours or location – to meet the demands of the new economy.
- Policymakers must be mindful of the social implications of such rapid change. This means investing in the means to understand the profile of the winners and losers from the disruption: their age, background and geographical location: an early warning system to put measures in place to compensate those bearing the brunt of the change.
- In the medium term, this may have implications for fiscal policy, as a matter of redistributing the economic gains to ensure a smooth transition for those who lose out. In the longer term, it also means understanding the impact on the trajectory of the earnings and wellbeing of different cohorts of society. As workers respond to the shifting landscape, what will it imply for the quality of work – the level and security of income and the quality of life across the population?
- As part of this challenge, policymakers are also charged with facilitating the skills transition the economy needs to take advantage of the opportunities technology will bring. This means understanding the multifaceted nature of the skills challenge that technological change presents, and the training vehicles to meet it. Some skills, such as mathematics, science and computer programming typically need long periods of formal study and experience. That means a long lead time, expensive educational institutions and dedicated education policies. Others require softer skills, which might shift the impetus to short-courses, mobile learning, on-the-job training and better job matching.

Educators

- Australia's education and training institutions will play a critical role. They must ensure an efficient and relevant pipeline of skilled workers is in place to feed the workforce, to fill emerging skills gaps as quickly as possible.
- Alongside the need for formal and technical training provision, our analysis points to the demand for softer, more cognitive and socially interactive skills in the future labour market, compared to today. These skills may require a wholly more flexible and bespoke delivery mechanism. It is not sufficient to focus on new graduates. The scale of disruption requires a much broader base for lifelong learning opportunities, for workers to refresh their skillsets and remain relevant.
- Educators must embrace technology solutions to deliver training, and to work in unison with employers to deliver relevant skills where they are most needed.

Employers

- On-the-job training and learning-by-doing, have long underpinned the productivity of the workforce. In the next ten years, much of the responsibility for preparing today's workers for future needs falls at the feet of employers. Businesses and organisations that can deliver relevant skills quickly and effectively will find a competitive edge.
- But employers will not achieve this in isolation. An ecosystem of training partners is required across the economy. Cutting-edge training solutions such as remote learning and augmented reality will complement traditional approaches to enable organisations to retain the institutional knowledge and experience of their staff, whilst upskilling their workforce to get the most out of new technological capabilities.

For the Australian economy, the next decade of technological progress and the ingenuity businesses show in its application, will have profound implications for the dynamism of the economy and the nature of work. How well the stakeholders in Australia's future can capitalise on those opportunities, for the net benefit of the whole population, will depend on how well it deals with the skills transition.

Appendix

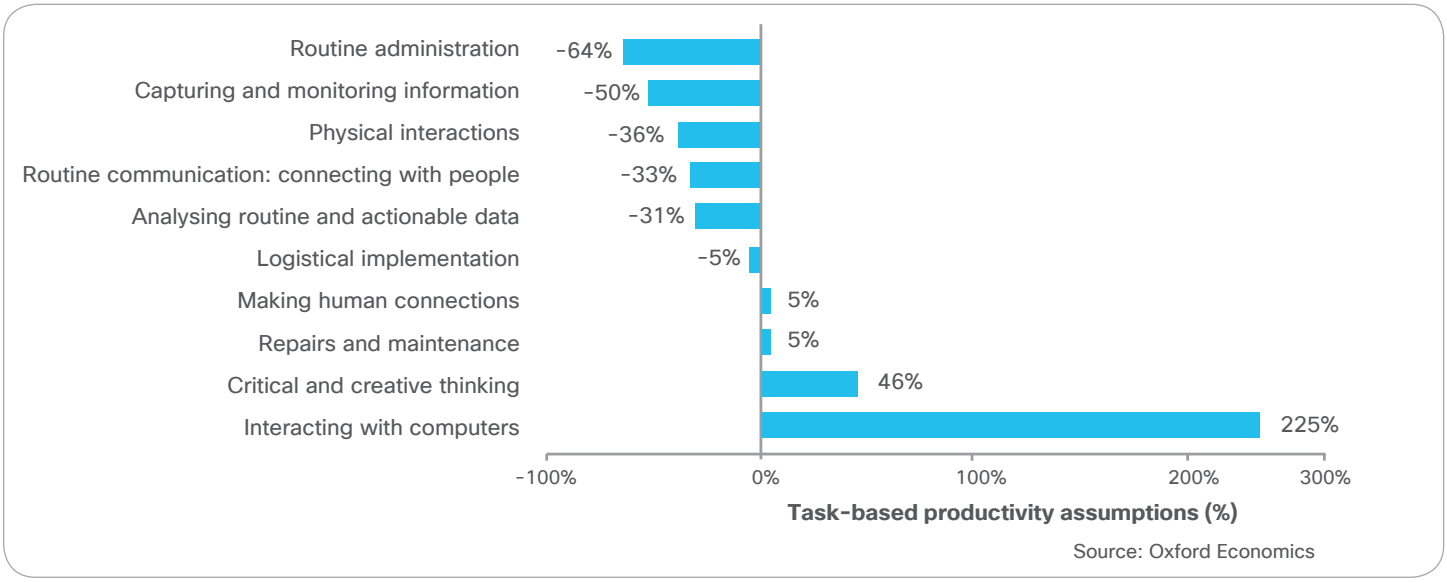
Appendix 1: Our modelling assumptions

As part of the 2017 US study, Cisco and Oxford Economics assembled a team of technology experts to engage in an interactive workshop and develop a detailed hypothesis about the likely progress of technology over the coming decade. Participants were tasked to form a collective judgement on the future capabilities of a range of technologies, including artificial intelligence, advanced robotics and IoT, and how they would change the nature of work. They were asked "To what extent will businesses become more productive at performing certain tasks, such that fewer workers will be required to produce the same output?"

They considered the extent of technological progress, as well as the rate of business investment, and other institutional, political and infrastructural challenges that defined the context in USA. This helped us formulate a set of consistent task-based productivity assumptions across 41 workplace tasks that are a key input to our labour market modelling framework.

Below is a summary of the results from the interactive workshop applied to the Australian labour market, aggregating the 41 workplace tasks into 10 task clusters.

Figure 17. Productivity assumptions by task cluster



Limitations of the study for sector-specific insights

The principal modelling challenge for this study is to explore long-term implications of technological change on Australia's labour market. We developed generic, task-based assumptions about how technology will change enterprises' capabilities over the period, which can be mapped to the entire labour market via the task-profiles of different occupations, and the occupational mix of employment in different sectors. For this framework to hold, one must assume that, over a 10 year period, if technology is capable of performing a certain task in one sector, e.g. observing the quantities of things on a food production line using pattern recognition technology, then the same broad technological solution will be applicable to all sectors in which observing the quantities of things is required, e.g. a security guard at an entertainment venue. This framework enables us to take a cross-sectoral perspective on the potential impact of a single technology scenario over a 10 year period, based on the task-content of work in each sector. However, it does not allow for a more contextual understanding of the sector-specific barriers – or catalysts – that might differentiate that impact over time. This limitation should be considered when interpreting our sector-level outputs. The ultimate impact could be greater or smaller than the central case presented, depending on sector-specific factors affecting the rate of technology adoption.

Appendix 2: Modelling the labour market impact

Our modelling framework is designed to explore the implications of technological change on the shape of the Australian labour market. It is based on a long-term assumption of equilibrium employment and therefore does not attempt to forecast fluctuations in the rate of unemployment. Our model makes use of granular industry-occupation employment matrices sourced from the Australian Bureau of Statistics, which represent today's labour market equilibrium. This is combined with data from O*NET on the nature of occupations, providing a comprehensive account of the skills (35 categories) and workplaces tasks[11] (41 categories) for each job, as well as other characteristics[12]. Our scenario projections represent a shift in the structure of the labour market compared to today's equilibrium. Our approach involves a sequence of two modelling exercises, which we set out below.

Modelling the static displacement effect

The displacement effect was derived from consensus expert judgements in an interactive workshop, as described in Box 1. The workshop produced quantitative assumptions about the extent to which technology would make us more productive in the future in producing the equivalent of today's level of output. In doing so, it would "displace" workers from performing specific tasks that are more amenable to automation. These "task changes" were mapped to occupations based on the task-profiles of 433 occupations[13] in the Australian labour market, which were produced using O*NET data.

The task profile of a given occupation[14] (o) provides an estimate of the share of working time spent completing each workplace task (t). It is calculated using the relative importance (IM) of each workplace task, only including tasks that are deemed important for that occupation. The importance score is derived from O*NET data, which gives each task for each occupation a score from 1-5. We normalise this score on a 0-100 scale and label all tasks with a score greater than or equal to 50 as "important" to a given occupation. By way of context, the 433 occupations involve an average of 23 "important" tasks. Cleaners, for example, have six important tasks to complete, whilst conference and event planners have 35. The estimated share of working time spent on task 1 for occupation o is therefore as follows:

$$(1)\quad T_{o1} = \frac{IM_{o1}}{\sum_{t=1}^{41} IM_{ot}} \; where \; IM_{ot} \geq 50$$

Our expert panel produced task-specific assumptions about the change in FTE employment required to perform each task. This resulted in a new occupational task profile, where β_t is the static displacement effect for task.

$$(2)\quad T_{o1}^{d} = \frac{IM_{o1}(1+\beta_1)}{\sum_{t=1}^{41} IM_{ot}(1+\beta_t)} \; where \; IM_{ot} \geq 50$$

The implied impact on FTE employment from the displacement effect was calculated for each occupation (ΔEmp_o^d) based on the gross reduction in FTE hours required to complete each task under the technology scenario, compared to baseline (3). The labour market-wide impact was calculated as the sum of the occupational effects (4).

$$(3)\quad \Delta Emp_o^d = Emp_o^d - Emp_o^{2018} \quad \text{where } Emp_o^d = \sum_{t=1}^{41} T_{ot}(1+\beta_t)\, Emp_o^{2018}$$

$$(4)\quad \Delta Emp^D = \sum \Delta Emp_o^d$$

[11] Referred to as Generalised Work Activities in O*NET

[12] All O*NET data is mapped from US Standard Occupation Classifications to ISCO 08 in order to be incorporated with the industry-occupation employment matrices for Australia.

[13] 4-digit occupations in the International Standard Classification of Occupations 2008

[14] O*NET data is not industry specific, therefore the displacement effect is the same across industries for a particular occupation

Whilst the expert panel dictated that most tasks would be subject to productivity gains over the next decade, i.e. a negative displacement effect, some tasks would see an increase in demand for workers as a necessary corollary of achieving those productivity gains. An example is that workers would have to 'interact more with computers', in order to achieve technology-based productivity gains in other tasks, such as 'inspecting equipment'. These "positive displacements" are interpreted differently to negative displacements. They are interpreted solely as a change in the task-composition of an occupation, which results in a rise in aggregate hours the worker spends on that task at the expense of other tasks, such that the net FTE employment for the occupation is unchanged. Therefore, the total displacement effect for each individual occupation is always non-positive. For interacting with computers specifically, an additional assumption is imposed, stating that this task becomes important for more jobs, based on an adjustment in the importance threshold for this task.[15]

Modelling the income effect

The income effect occurs as a result of increased demand for goods and services and offsets the displacement effect on employment. Where that demand falls, i.e. how people spend their extra income – is independent of where technology is generating productivity gains. To estimate the income effect, we took GVA growth forecasts for Australia from the Oxford Economics Global Industry Model and derived the implications for individual occupations using the industry-occupation employment matrices.

In the real world, the displacement and income effect occur in parallel. However, technically we estimated the displacement effect of our technology scenario first. We take the post-displacement employment for occupation o in industry $I(Emp^{d}_{io})$, then apply the GVA forecast for industry $i(\Delta GVA_i)$[16] and sum across all industries to estimate the net change in employment level for occupation o (ΔEmp^{ie}_{o}).

(5) $\Delta Emp^{ie}_{o} = \sum_{i=1}^{19} \Delta GVA_i * Emp^{d}_{io}$

The aggregate income effect on FTE employment was calculated as the sum of all occupational impacts and, for modelling purposes, was constrained in FTE employment terms to equal the aggregate displacement effect, as expressed in (6). In fact, the income effect exceeded the displacement effect, but the residual is presumed to be driven by other, non-technology related productivity gains that are correlated to digitalisation.

(6) $\Delta Emp^{I} = \Delta Emp^{D}$

Skills Matching Model

The Skills Matching Model was designed to match vacant positions in the labor market with viable candidates, iteratively filling the vacancies until no surplus workers remain and equilibrium is restored. The matching algorithm considers both the viability of a move from one occupation to another in terms of job compatibility, as well as the wage dynamics that would play out in practice, to incentivize the movement of labor in the evolving economy.

Changes in the demand and supply of labor brought about by the displacement and income effects will affect wages in each occupation. For occupations that experience high growth in labor demand, wages will be expected to rise and the probability of workers in those occupations wanting to move will fall. For occupations that experience a large reduction in labor demand, the opposite will happen: workers in these occupations will be willing to accept lower wages and they will be more likely to move jobs.

[15] Importance threshold is lower to 25 (out of 100)

[16] % growth in GVA over the next 10 years (2018-2028)

These dynamics are embedded in the historical job moves data to an extent but given the uniqueness of the labor market "shock" we are modelling (in which we process ten years' worth of technological change concurrently), the wage dynamics surpass those experienced in the past. For that reason, we incorporate a Wage Adjustment Factor (WAF_i^j) into the model equation. The WAF for a sending occupation (i), in the context of a move to a receiving occupation (j), reflects the difference in wage pressures between the two ($\%\Delta Emp_j - \%\Delta Emp_i$), relative to the wage pressure being felt in other, competing, sending occupations.[17] When the difference in wage pressure between a receiving and sending occupation is greater than the average wage pressure differential related to that receiving occupation, the WAF will be greater than one, and the likelihood of that move taking place will therefore be greater than the historical data suggests. When the relative wage pressure is smaller than average for a move to the receiving occupation, the WAF will be less than one and the likelihood of the move taking place will therefore be lower than historical data suggests.

$$(7)\quad WAF_i^j = \frac{\%\Delta Emp_j - \%\Delta Emp_i}{\frac{1}{M}\sum_{i=1}^{M}(\%\Delta Emp_j - \%\Delta Emp_i)} \qquad \text{where M} = \text{number of potential sending occupations}$$

The model solves iteratively by filling one vacancy[18] at a time and recalculating the relative wage-adjustment factors after each iteration. Each iteration starts by taking the occupation with the greatest upward wage pressure (i.e. the greatest proportion of vacancies), calculating the relative wage-adjustment factors for all potential sending occupations and therefore deriving the probability that the vacancy is filled by those occupations. Once that vacancy is filled, the wage pressure experienced by that occupation will fall. Therefore, the wage pressure is recalculated, and the next iteration begins. The model will step through each iteration until all vacancies have been filled and the labor market has returned to equilibrium.[19] As wage pressures dissipate, the WAF tends to one, meaning the probability matrix tends back to historical probabilities.

[17] Relative wage-adjustment factors are constrained so the probabilities sum to 100%

[18] Due to computational constraints 10% of the initial required vacancies for a given occupation are filled in each iteration rather than one single vacancy.

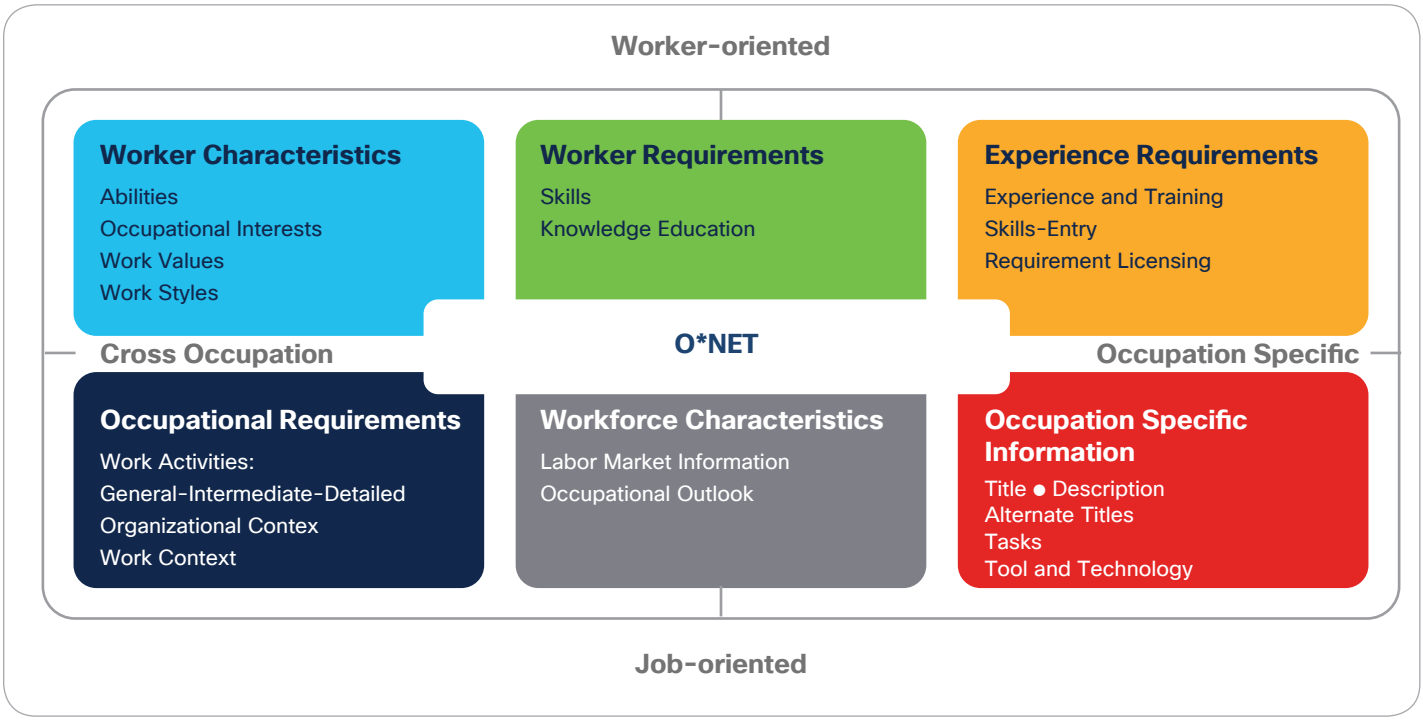
[19] In order to prevent workers moving back and forth between occupations, a rule was set up that prevents a vacancy being filled by an occupation with a similar wage pressure.

Appendix 3: What is O*NET and how did we use it?

The US O*NET program is a comprehensive system for collecting and disseminating information on occupational and worker characteristics, sponsored by the US Department of Labor and Employment and Training Administration. At the center of the program is the O*NET database, which contains information on hundreds of standardised and occupation-specific descriptors for over 1000 different occupations. All of these data are structured according to the O*NET "content model", which defines the key features of an occupation as a standardised set of variables called "descriptors". The descriptors are meant to provide an exhaustive list of all the worker characteristics, worker requirements and occupation requirements for any given occupation. Information is organised across six "domains" which comprise both worker-oriented characteristics and job-oriented characteristics. Please see table below for illustration of the "content model".

Much of the information is collected via self-reported assessments by existing employees using standardised questionnaire surveys and is supplemented by professional assessments by job evaluation analysts. These data collection methods are undertaken on an ongoing basis, enabling information to be updated regularly, and has created a rich time-series database of occupation-specific descriptors spanning almost 20 years. All data was mapped into international occupation codes (ISCO) using the publicly available crosswalks from O*NET and the US Bureau of Labor Statistics.

Figure 18. Specific details on skills and work activities



For this paper, the core data used from the O*NET database were the "Skills" and "Generalized Work Activities" sections. For both elements, the "Importance" and "Level" of each skill or characteristic is recorded. The former reflects the degree of importance a particular descriptor has to the occupation and is scored from one ("not important") to five ("extremely important"). The latter reflects the degree to which a particular descriptor is required to perform the occupation. It is scored according to a 0-7 scale with reference points (or "level anchors") to help respondents place a value on that range.

The descriptors included in both of these sections are meant to be exhaustive and mutually exclusive. For example, the 35 skill descriptors should provide a comprehensive list of all the skills that might be required by a worker in any given occupation in the US. The table below presents the typology used for the "Skills" and "Generalized Work Activities" sections of the O*NET database.

Figure 19. Skills typology[20]

Category	Descriptor
Cognitive skills	• Complex problem solving • Critical thinking • Judgement and decision making • Mathematics • Science
Foundational skills	• Active learning • Active listening • Learning strategies • Monitoring • Reading comprehension • Speaking • Writing
Interactive skills	• Coordination • Instructing • Negotiation • Persuasion • Service orientation • Social perceptiveness
IT skills	• Programming • Systems analysis • Systems evaluation • Technology design

[20] The categories used in this report differ to those used by O*NET

Category	Descriptor
Operations skills	• Equipment maintenance • Equipment selection • Installation • Operation and control • Operation monitoring • Operations analysis • Quality control analysis • Repairing • Troubleshooting
Resource management skills	• Time management • Management of financial resources • Management of material resources • Management of personnel resources

Figure 20. Work activities (tasks) typology[21]

Category	Descriptor
Analysing routine and actionable data	• Analysing data or information • Controlling machines and processes • Estimating quantifiable characteristics of products, events, or information • Evaluating information to determine compliance with standards • Identifying objects, actions, and events • Processing information
Capturing and monitoring information	• Drafting, laying out, and specifying technical devices, parts and equipment • Getting information • Inspecting equipment, structures, or material • Monitor processes, materials, or surroundings • Monitoring and controlling resources

[21] The categories used in this report differ to those used by O*NET

Category	Descriptor
Critical and creative thinking	• Interpreting the meaning of information for others • Judging the qualities of things, services, or people • Making decisions and solving problems • Thinking creatively • Updating and using relevant knowledge
Interacting with computers	• Interacting with computers
Logistical implementation	• Coordinating the work and activities of others • Developing objectives and strategies • Organizing, planning, and prioritizing work • Staffing organizational units
Making human connections	• Assisting and caring for others • Developing and building teams • Establishing and maintaining interpersonal relationships • Guiding, directing, and motivating subordinates • Performing for or working directly with the public • Provide consultation and advice to others • Resolving conflicts and negotiating with others • Selling or influencing others
Physical interactions	• Handling and moving objects • Operating vehicles, mechanized devices, or equipment • Performing general physical activities
Repairs and maintenance	• Repairing and maintaining electronic equipment • Repairing and maintaining mechanical equipment
Routine administration	• Documenting/recording information • Performing administrative activities • Scheduling work and activities
Routine communication	• Coaching and developing others • Communicating with persons outside organization • Communicating with supervisors, peers, or subordinates • Training and teaching others

About Oxford Economics

Oxford Economics was founded in 1981 as a commercial venture with Oxford University's business college to provide economic forecasting and modelling to UK companies and financial institutions expanding abroad. Since then, we have become one of the world's foremost independent global advisory firms, providing reports, forecasts and analytical tools on more than 200 countries, 250 industrial sectors, and 7,000 cities and regions. Our best-of-class global economic and industry models and analytical tools give us an unparalleled ability to forecast external market trends and assess their economic, social and business impact.

Headquartered in Oxford, England, with regional centres in London, New York, and Singapore, Oxford Economics has offices across the globe in Belfast, Boston, Cape Town, Chicago, Dubai, Frankfurt, Hong Kong, Houston, Johannesburg, Los Angeles, Melbourne, Mexico City, Milan, Paris, Philadelphia, Sydney, Tokyo, and Toronto. We employ 400 full-time staff, including more than 250 professional economists, industry experts and business editors—one of the largest teams of macroeconomists and thought leadership specialists. Our global team is highly skilled in a full range of research techniques and thought leadership capabilities, from econometric modelling, scenario framing, and economic impact analysis to market surveys, case studies, expert panels, and web analytics.

Oxford Economics is a key adviser to corporate, financial and government decision-makers and thought leaders. Our worldwide client base now comprises over 1,500 international organisations, including leading multinational companies and financial institutions; key government bodies and trade associations; and top universities, consultancies, and think tanks.

August 2019

The modelling and results presented here are based on information provided by third parties, upon which Oxford Economics has relied in producing its report and forecasts in good faith. Any subsequent revision or update of those data will affect the assessments and projections shown.

To discuss the report further please contact:

James Lambert: jlambert@oxfordeconomics.com

Oxford Economics, Broadwall House, 21 Broadwall, London, SE1 9PL, UK

Tel: +44 203 910 8000