fya

THE NEW WORK MINDSET

7 new job clusters to help young people navigate the new work order

The Foundation for Young Australians (FYA) is committed to young people, their futures and the contribution they can make to Australia. At FYA, we believe young people are ambitious, creative and capable of rethinking the world and solving tomorrow's problems today. FYA is a national for-purpose organisation that is all about backing the next generation of young people who are going to rethink the world and create a better future. At FYA we connect and inspire young changemakers - the innovators, the makers, the dreamers, the thinkers, the doers and the creators.

Find out more at **fya.org.au**

This report is part of FYA's 'New Work Order' series.

This report was prepared for the Foundation for Young Australians by AlphaBeta.

AlphaBeta is a strategy and economic advisory business serving clients across Australia and Asia from offices in Singapore and Sydney. For further information contact AlphaBeta at Sydney@alphabeta.com

FOREWORD

There is an urgent need to shift mindsets in our approach to jobs, careers and work. New big data analysis provides us with insights into the patterns of skills young people now require to navigate complex and uncertain working lives. We must act now to ensure young Australians can thrive in the new world of work.

FYA embarked on the New Work Order report series in mid-2015. Our first report, **The New Work Order**, showed the way we work will be increasingly affected by three global economic forces; automation, globalisation and collaboration. It highlighted that if we want young people to capitalise on these opportunities and navigate the challenges brought by these changes, they need a set of transferrable enterprise skills.

How are young people faring in the transition from school to work showed a gap between the enterprising skillset young Australians need and their level of attainment. Around 35% of Australian 15-year-olds showed low proficiency in problem solving, 27% demonstrated low proficiency in digital literacy and 29% demonstrated low proficiency in financial literacy.

Most recently, **The New Basics**, analysed 4.2 million job advertisements between 2012 and 2015 to show that the changes we have been predicting are already here. More employers are demanding enterprising skills among young employees. Demand for digital skills went up 212% over three years, while critical thinking increased 158%, creativity increased by 65% and presentation skills by 25%.

These reports have showed the urgent need for investment in a national enterprise skills and careers education strategy that would:

- Begin early in primary school and build consistently, year on year, throughout high school

- Be provided in ways that young people want to learn: through experience, immersion and with peers

- Provide accurate information about and exposure to where future jobs will exist and the skills to craft and navigate multiple careers

- Engage students, schools, industry and parents in co-designing opportunities in and outside the classroom.

To tackle the challenge of providing accurate information about where future jobs will exist and the skills that will be needed we have again turned to big data. **The New Work Mindset** has analysed more than 2.7 million job advertisements to reveal 7 new job clusters in the Australian economy where the required skills are closely related and more portable than previously thought.

What the report ultimately reveals is that current careers advice is already outdated in the New Work Order predicted. When we talk about the future of work, much of the focus is on which jobs will disappear and which will remain. These are important factors, however this report shows that we need to shift our focus from jobs to skills to prepare young people for the future of work.

By understanding the skills and capabilities that will be most portable and in demand in the new economy, young people can work to equip themselves for the future of work more effectively. Our mindset needs to shift to reflect a more dynamic future of work where linear careers will be far less common and young people will need a portfolio of skills and capabilities, including career management skills to navigate the more complex world of work.

For example, a young person within 'The Informers' cluster which comprises jobs requiring skill in providing information, education or business services, will be able to more easily shift between roles in a job cluster with the right portable technical skills. There may be a few skill gaps which can be filled with additional training or experience, however the focus on building a portfolio of skills to navigate a cluster over a single, dream job is key.

These findings also highlight risks. We know that not all the job clusters will have strong future prospects which may drive unemployment and inequality. Young people need accurate information to help them make decisions about which job clusters they are most suited to and where they are likely to have most longevity.

We want a new mindset towards how we approach working lives and our existing systems will need to shift. We hope to see our government, educators, tertiary institutions, young people and parents embrace this new work mindset so that all young Australians are able to not only survive but thrive in the new work order.

Jan Owen
CEO
Foundation for Young Australians

There are 7 new job clusters in Australia

'TheGenerators'

'The Artisans'

'The Carers'

'The Informers'

'The Coordinators'

'The Designers'
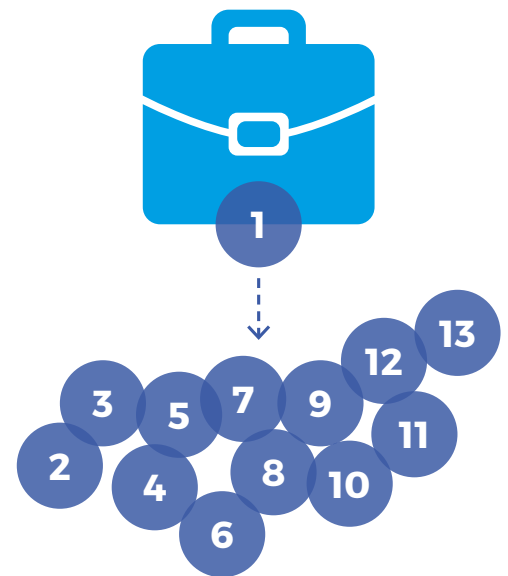
'The Technologists'

A young person...

- could choose a job cluster based on their interest and strengths rather than focus on one dream job.

- could gain experience through early career jobs in the job cluster.
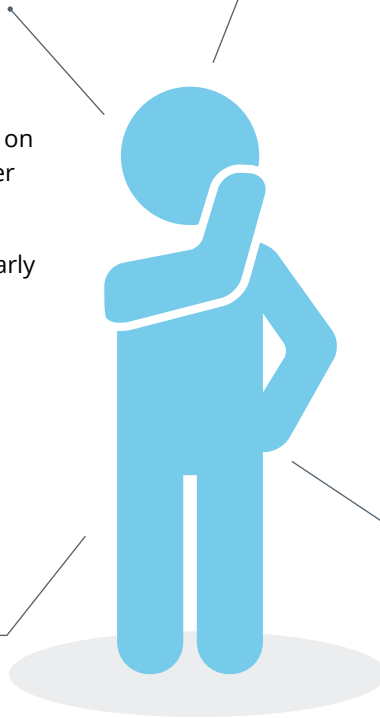
Jobs are more related than we realise...

When a person trains or works in 1 job, they acquire skills for 13 other jobs*

1

13
12
3 5 7 9 11
2 4 8 10
6

Some job clusters have stronger future prospects than others

Job clusters require similar skills that are often portable across jobs

A young person...

- could focus on developing a portfolio of technical and enterprising skills common to their chosen job cluster.

JOBS OF THE **FUTURE**

JOBS OF THE **PAST**

'The Carers'

'The Informers'

'The Technologists'
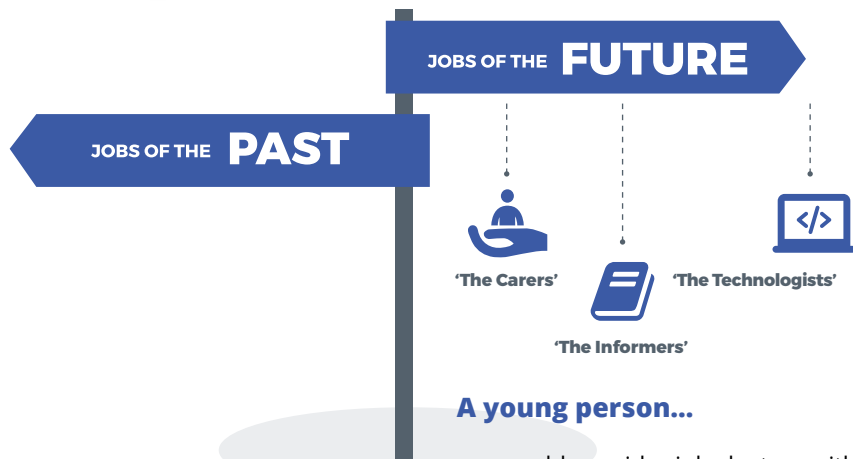
A young person...

- could consider job clusters with strongest future prospects and jobs that are most likely to grow.

*On average, based on high overlap of skills.

CONTENTS

Work is changing

People often think of careers as a climb up the ranks of job seniority, starting in the trainee cubicle and aiming for the executive offices. Today careers are often not so linear. While virtually every child is asked, 'What do you want to be when you grow up?', only 6% of adults end up in the careers they wanted when they were younger.[1] Instead of training for a particular occupation and working in that area for life, some studies have estimated that Australians will make 17 changes in employers across 5 different careers.[2] Compounding the uncertainty is the reality that many jobs of the future don't exist today. The World Economic Forum has argued that "in many industries and countries, the most in-demand occupations or specialties did not exist 10 years ago."[3] In fact, in Australia, over the past 25 years, we have lost 1 million jobs in manufacturing, administration and labouring but gained more than 1 million jobs in the knowledge and service industries.[4] FYA's previous reports on 'The New Work Order' have highlighted the dynamism and complexity at play in the future of work.

Amidst this uncertainty, every young Australian has to make choices that will affect their future options like: what subjects to study at school; what courses to take at TAFE or university; what apprenticeships to go for; and what first job they should apply for? While none of these choices are irreversible, they are important because they collectively shape our career and employment options over time. In order for young people to make decisions, they need to have information that simplifies the complex world of work and helps them navigate work over a lifetime. This report uses a new methodology for analysing the patterns contained in millions of online job advertisements, in order to shed new light on navigating uncertainty.

Our skills are more portable than we realise

The dynamism and uncertainty of work represents a potentially exciting opportunity for young people. The media often focuses on automation and globalisation because of concerns that workers will not be able to utilise their skills in jobs as they change or new jobs as they emerge. It is commonly viewed that moving from one occupation to another would entail high switching and retraining costs.

However, jobs are more related than we might first think. Not all jobs require the acquisition of an entirely new skill set, instead, the skill sets of many jobs are 'portable' to other jobs. In fact, on average, when an individual trains or works in 1 job, they acquire skills for 13 other jobs. This is because, for many jobs, employers demand very similar skills. Most young people are skilled for more jobs (see section 1 for detail) than they or potential employers, actually realise.

[1] Javier G. Polavieja and Lucinda Platt, "Nurse or Mechanic? The Role of Parental Socialization and Children's Personality in the Formation of Sex-Typed Occupational Aspirations", Social Forces (2014) 93 (1): 31-61 first published online May 12, 2014

[2] McCrindle Research (2014) "Job mobility in Australia" using HILDA and Department of Employment data. Available at: http://mccrindle.com.au/the-mccrindle-blog/job-mobility-in-australia

[3] World Economic Forum (January 2016) "The Future of Jobs: Employment, skills and workforce strategy for the Fourth Industry Revolution" Available at http://www3.weforum.org/docs/WEF_Future_of_Jobs.pdf

[4] Foundation for Young Australians (2015) "The New Work Order: Ensuring young Australians have skills and experience for the jobs of the future, not the past"

Of course job switches will often require additional technical skills or subject matter expertise. Even in related fields with many common characteristics, moving between jobs can be challenging. On the other hand, some job switches only demand a few new skills. In fact, for someone who has already trained for or worked in one job, 44 different jobs only request one additional skill.

The portability of skills has important implications for how we think about our careers and provide career education. Many jobs are related and require similar skills. Rather than choosing an occupation with an unbroken path to seniority, a young person could think about developing a portfolio of skills that opens doors to a group or 'cluster' of jobs. Rather than asking a young person, what is your 'dream job', it may be more useful to ask what is your 'dream job cluster'?

This report seeks to help shift our mindset around work by asking and answering a number of career-shaping questions.

What are the new clusters of work?

Which job cluster could a young person choose? How do they gain work experience?
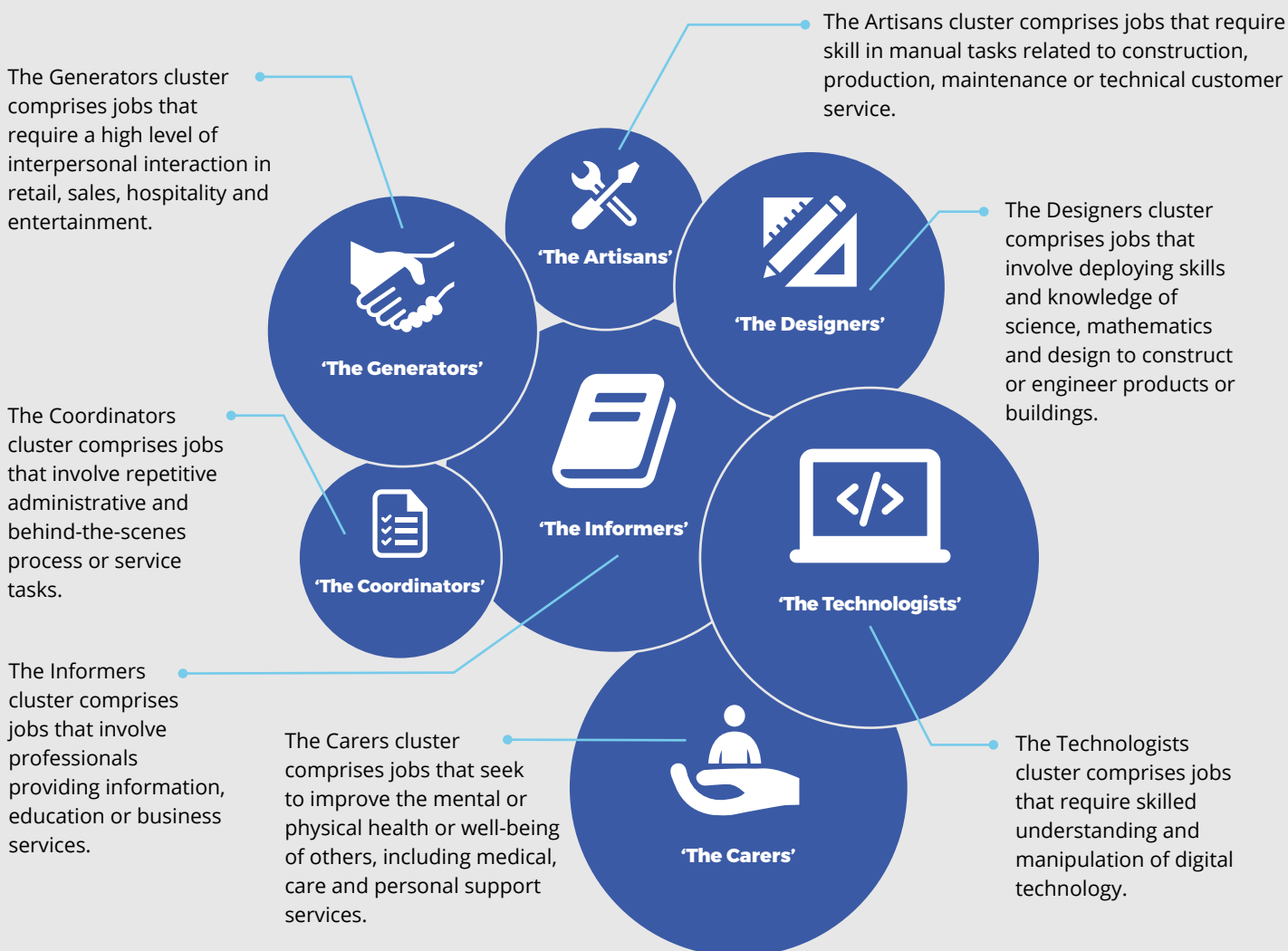
What skills does a young person need to build a career moving through these clusters?

Which jobs have promising future prospects?

There are 7 new job clusters in Australia

There are more than 1,000 different occupations in Australia. This might seem like a bewildering choice for a young person starting their career, but actually many of these jobs are related in the sense that they involve similar skills, day-to-day tasks and work environments (some of which are surprising).

By using a first-time methodology for analysing millions of job advertisements, these occupations can actually be grouped into just 7 'clusters of work':

The Generators cluster comprises jobs that require a high level of interpersonal interaction in retail, sales, hospitality and entertainment.

The Artisans cluster comprises jobs that require skill in manual tasks related to construction, production, maintenance or technical customer service.

The Designers cluster comprises jobs that involve deploying skills and knowledge of science, mathematics and design to construct or engineer products or buildings.

The Coordinators cluster comprises jobs that involve repetitive administrative and behind-the-scenes process or service tasks.

The Informers cluster comprises jobs that involve professionals providing information, education or business services.

The Carers cluster comprises jobs that seek to improve the mental or physical health or well-being of others, including medical, care and personal support services.

The Technologists cluster comprises jobs that require skilled understanding and manipulation of digital technology.

'The Generators'
'The Artisans'
'The Designers'
'The Coordinators'
'The Informers'
'The Technologists'
'The Carers'

In order to uncover the clusters of work in Australia, the 4,600 unique skills requested by employers across 2.7 million online job advertisements[5] were analysed with an exciting new methodology. Using a clustering algorithm, over 1000 occupations were grouped based on whether employers demanded similar skills from candidates. For example, The Carers cluster of work comprises jobs that seek to improve the mental or physical health or well-being of others, including medical, care and personal support services. The 131 occupations[6] currently in this job cluster include GPs, social workers, childcare workers, fitness instructors, surgeons, counsellors and beauty therapists. The algorithm groups these occupations together into one cluster based on their common skills including both the top technical skills (like computer-aided drafting, accountancy, or case management) and the top enterprise skills (like problem solving, communications, and project management).

Choosing a first job is a big decision. But it's only the beginning of a career journey that could encompass many transitions between different roles across multiple fields. Instead of a young person focusing purely on choosing a single job, they could consider a more long-term question, such as which 'cluster of work' they want to build a career within. When making this decision a young person can:

- Reflect on the job clusters that best match their interests and strengths, by using the jobs and skills most commonly request in a job cluster as a guide.

- Test their fit within a job cluster by gaining critical early-career experience in jobs that employers offer more frequently to young people.

## Job clusters require similar skills that are often portable across jobs

In order to enter, succeed and move around in a job cluster, young people will need the relevant technical and enterprise skills. Young people will likely require a combination of formal training, on-the-job training and experiential learning to develop both the specific technical skills, such as JavaScript, CAD or forklift operation, and the most highly-demanded enterprise skills, such as team work, creativity or problem solving.

Workers and employers often think of technical skills as specific to a particular job or task, such as surgical skills if you are a veterinarian or JavaScript if you are a computer programmer. However, online job advertisements reveal that many technical skills appear across multiple occupations in a cluster of work and are not just specific to a single job. A specific job will often still require a

specific technical skill or subject matter expertise but picking up many of the core technical skills within a job cluster will enable young people to move within a cluster of work and more easily shift into the unknown jobs of the future.

Enterprise skills are transferable skills that enable young people to engage with a complex working world and which have been found to be a powerful predictor of long-term job success. While there are some enterprise skills that are commonly sought across job clusters, such as communication skills, digital literacy, writing, training others, and problem solving, employers in different clusters of work demand some enterprise skills more often than others. For example, The Artisans job cluster focuses primarily on the capacity to train others, problem solve and manage time, whereas the Informers job cluster requests skills related to writing, problem solving, research, creativity and team work.

The set of core technical and enterprise skills outlined for each job cluster in this report can be used by young people to identify the types of courses they might want to enroll in or work experience they might want to acquire. Likewise, educators and policy makers could use the common skills requested by job clusters to help design the offerings that are core to multiple curricula. Moreover, given the portability of skills across our different jobs and the potential to add one or two additional skills, workers, educators and policy makers can now think more strategically about preparing young people to navigate dynamic working lives.

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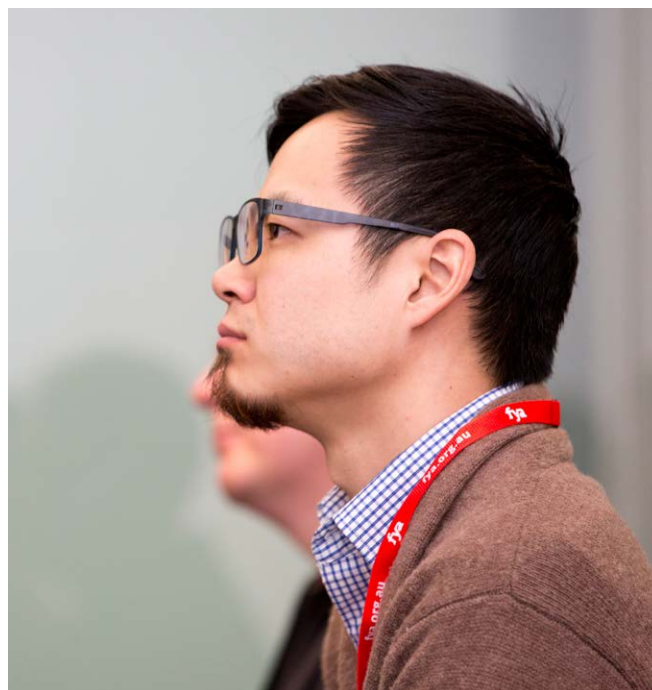
[5] Data for this report was primarily sourced from Burning Glass Labor Insight™ database. For more information about this data source, please contact Sydney@alphabeta.com

[6] Job is defined as a 6-digit occupation code in the ABS ANZSCO classification of occupations. This is the most granular level of occupation.

Some job clusters have stronger future prospects than others

While it is helpful to understand the current labour market, young people in Australia also need information about the labour market of the future, to help guide the decisions they need to make about training and entry-level job applications.

Each of the 7 job clusters have different future prospects, with some offering greater long term security than others on average. To understand the future prospects of each job cluster, the occupations within each cluster were ranked on likely future growth[7] and resistance to automation.[8] Of the 7 clusters of work: The Artisans and The Coordinators are likely to experience lower growth and high exposure to automation; The Generators and The Designers are likely to experience moderate growth and medium exposure to automation; and The Carers, The Informers, and The Technologists are most likely to grow and persist into the future. Over time, the jobs that comprise these clusters of work will change, as will the names and number of clusters of work. More job clusters may arise, based on new occupations and new skills being demanded and valued by employers.

When selecting their preferred job cluster, young people could consider those with the strongest future prospects. However, irrespective of the different prospects for job clusters as a whole, young people could also navigate their way in the job cluster by targeting roles that are most likely to grow.

The New Mindset: Helping young people to navigate work now and in the future

This report continues our national conversation on how to reconceptualise the future of work. So much of the existing information available to young people paints an incomplete picture: lists of the top 10 jobs of the future, the industries or roles that are predicted to grow most quickly, or the advanced digital skills they will require. Instead, big data can be used to inform young people, educators and parents about the skill patterns, or footprints, that exist in our labour market and will persist into the future.

By conducting analysis of the skills requested in millions of job advertisements, it is clear that conversation about work needs to progress beyond the 1000+ occupations that comprise the economy. A number of potential implications arise for employers, parents, young people, educators and policy makers. Section 6 outlines some options that can be considered in supporting young people to navigate the New Work Order.

[7] Total five-year job growth for occupations within a job cluster, measured over the period 2010 to 2015. Source: ABS. See Appendix A.3 for a detailed methodology.

[8] Probability that the occupation will be affected by automation over the next 10-15 years. Source: Data provided by NICTA, as reported in CEDA (2015) 'Australia's Future Workforce', Chapter 1.4. See Appendix A.3 for a detailed methodology.

Methodology-in-brief: Uncovering the job clusters in Australia's economy
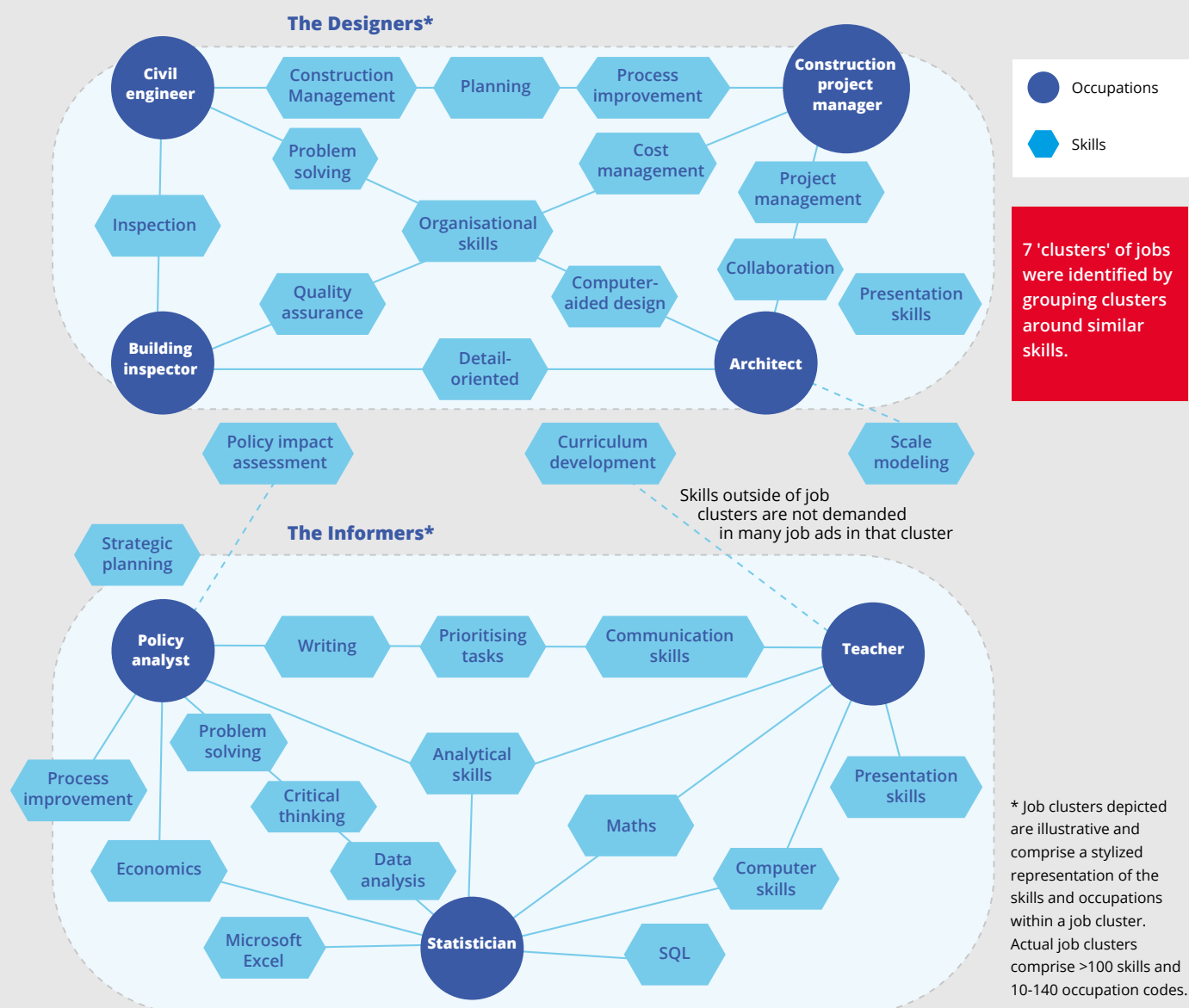
Rather than using anecdote or common sense to assess how jobs could be grouped or are related, it is more instructive to look at the technical and enterprise skills that employers actually request across millions of job advertisements. In order to uncover the clusters of work in Australia, the skills requested by employers across 2.7 million online job advertisements posted over the past two years were analysed. For each of the more than 600 occupations, the intensity (proportion of job ads requesting the skill) of approximately 4,600 unique skills were analysed and a similarity score assigned to each pair of occupations. Using a clustering algorithm, the occupations were then grouped based on whether employers demanded similar skills from applicants (See illustrative image below). For a detailed explanation of the clustering methodology, please see Appendix A.3.

A note on online job advertisements: While it is acknowledged that online job advertisements do not cover all jobs on offer in the workforce, research suggests they do represent a substantial proportion of demand for labour. The myth that some 80% of jobs are "hidden", or never advertised, has been quashed by recent analysis in the US of online job postings and Government vacancy surveys (Carnevale et al 2014). The research found that 60 to 70% of jobs are advertised online. Further, jobs that are less senior, and therefore more relevant to young people, are more likely to be advertised than recruited offline via networks.

Given that the data for this report is drawn from online job advertisements, the skills required for self-employment and entrepreneurship are likely to be under-represented.

Data for this report was primarily sourced from Burning Glass, Labor Insight. For more information on this data source, please contact Sydney@alphabeta.com

Job clusters were created by analysing 2.7 million job advertisements

The Designers*

- Civil engineer
- Construction Management
- Planning
- Process improvement
- Construction project manager
- Problem solving
- Cost management
- Project management
- Inspection
- Organisational skills
- Collaboration
- Quality assurance
- Computer-aided design
- Presentation skills
- Building inspector
- Detail-oriented
- Architect

Occupations
Skills

7 'clusters' of jobs were identified by grouping clusters around similar skills.

- Policy impact assessment
- Curriculum development
- Scale modeling

Skills outside of job clusters are not demanded in many job ads in that cluster

The Informers*

- Strategic planning
- Policy analyst
- Writing
- Prioritising tasks
- Communication skills
- Teacher
- Problem solving
- Analytical skills
- Process improvement
- Critical thinking
- Maths
- Presentation skills
- Economics
- Data analysis
- Computer skills
- Microsoft Excel
- Statistician
- SQL

* Job clusters depicted are illustrative and comprise a stylized representation of the skills and occupations within a job cluster. Actual job clusters comprise >100 skills and 10-140 occupation codes.

THE FUTURE OF WORK IS COMPLEX BUT OUR SKILLS ARE MORE PORTABLE THAN WE REALISE

The era of a tenured 'job for life' is over and most people move between roles through their careers. In fact, young Australians entering the workforce today might have as many as 5 different careers and make 17 changes in employers over their working lives.[9] The media often focuses on automation and globalisation because of concerns that workers will not be able to utilise their skills in jobs as they change or new jobs as they emerge. It is commonly viewed that moving from one occupation to another would entail high switching and retraining costs. However, jobs are more related than we might first think. Not all jobs require the acquisition of an entirely new skill set; instead, the skill sets of many jobs are 'portable' to other jobs. In fact, on average, when a person trains or works in 1 job, they acquire skills for 13 other jobs.[10] This is because, for many jobs, employers demand very similar skills.

Exhibit 1 provides an example from online jobs data of the portability of the skills gained as an Environmental Research Scientist. Environmental Research Scientist is portable into multiple other jobs, 13 of which are depicted in the exhibit. The skills gained by working or training as an Environmental Research Scientist are considered portable to the other roles like Medical Administrator, Fire Officer, Life Science Technician, and Zoologist because there is a high overlap of skills requested in these roles. For example, Environmental Research Scientist commonly requests communication skills, planning, research, project management, natural resource management, and skills in local government in its job ads. Likewise, a fire officer requests communication skills project management, skills in local government, natural resource management and environmental protection.

Of course, job switches will often demand additional technical skills or subject matter expertise that are acquired through lengthy formal or on-the-job training. But some job switches only demand a few new skills. In fact, for someone who has already trained for or worked in one job, 44 different jobs only request one additional skill.[11] If you are an aircraft baggage handler, for example, you might possess most of the top skills required to become a customs and inspection officer

except for knowledge on legal compliance and inspection. By understanding that jobs are more related and that skills are more portable between jobs than previously realised, there is an opportunity to be more strategic in navigating dynamic working lives. Rather than seeing learning as a one-off process before our first job or as a radical retraining to pivot careers, young people can build a portfolio of skills within a job cluster and target key learning areas to open up related job and career opportunities throughout their life course. The case study *"Zach's story of portability using real-life job ads data"* provides an example of an individual transitioning between roles by supplementing his existing portfolio of relevant skills with additional technical training.

This mindset shift is required not just of young people but of employers, educators, parents and policy makers. On the supply side, young people can think about how their existing skills would be valuable for multiple different roles. On the demand side, employers could consider the breadth of potential candidates from different occupations with similar skills. If this mindset shift was to take place, we might view the debate around a skills mismatch differently: training for one occupation and working in another occupation would not be a 'mismatch' if a person was deploying a relevant skillset.

When a person trains or works in 1 job, they acquire skills for 13 other jobs, on average
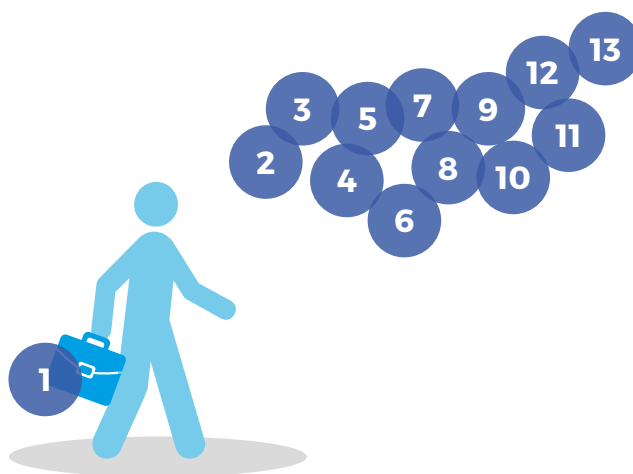
[10] Determined by the number of alternative jobs that demand skills that have already been acquired in the course of a given job. See Appendix A.5 for a detailed methodology.

[11] Determined by the number of alternative jobs that demand skills that have already been acquired in the course of a given job, plus require a single additional skill that is demanded at a higher intensity (>15% gap in the proportion of jobs demanding the skill) by alternative jobs than by the given job. Note that the 44 additional jobs do not request the same new skill but could each require the acquisition of a different single skill. These technical skills vary in difficulty and the time it takes to acquire the skill.

Exhibit 1: Skills acquired from one job are 'portable' to 13 other jobs, on average

**Example of skills that are transferable across jobs:
The portability of Environmental Research Scientist**

Zach's story of portability using real-life job ads data...

Zach is a 23-year old who has worked as a labourer for four years. He is looking for a change and is considering a move within his current job cluster, 'The Artisans'. He wants to use many of the skills he has already acquired as a labourer and looks at becoming a 'construction estimator'. A construction estimator quantifies the material, labour and equipment required to complete a building project.

- From his work and training as a labourer, Zach has acquired many of the top enterprise skills required for construction estimation. The most common enterprise skills demanded by both his labouring job and the construction estimation job are very similar, including communication skills, organisation skills, team work, time management and detail-orientation.

- Likewise, from his work and training as a labourer, many of Zach's technical skills are also portable. His knowledge about the construction industry, project management and construction management are among the top skills required to become a construction estimator. But he has a few technical and subject matter gaps: namely, estimating, cost estimating and computing skills.

Zach decides to fill these skill gaps by undertaking a short course at TAFE on Building and Construction (Estimating). Given his prior experience as a labourer, Zach gets some credit for a number of subjects where he has strong existing knowledge. His many relevant experiences as a labourer help him in his job interview with a large building company, where he now works in building scheduling and estimating.

Methodology-in-brief: Assessing portability of jobs

A persons' skills are considered 'portable' between jobs if each job demands the skills as frequently as the other. For example, despite the strong overlap of the (illustrative) skills between a Civil Engineer and an Architect, the skills of a Civil Engineer are not considered 'portable' to an Architect because one skill (creativity) is demanded too infrequently by Civil Engineer employers.

That is, if one skill has a difference in intensity (i.e. the proportion of job ads demanding the skill) of >15% between the jobs, the skills of one job are not considered portable to the new job (See illustrative image below).

For further detail on how portability was measured, please see Appendix A.4.

Example where skills are not portable between jobs

The intensity[1] of skill demand for all occupations are compared, and occupations with highly-similar skill intensities are deemed 'portable'				
Skill requested	**Civil Engineer**	**Architect**	**Skill intensity gap[2]**	
Problem solving	**53%** of jobs request this skill	**51%** of jobs request this skill	**2%**	✔
Mathematics	52%	44%	**8%**	✔
Computer-assisted drafting/design	63%	63%	**8%**	✔
Construction management	77%	20%	**57%**	✘
Technical drawing	42%	40%	**2%**	✔
Project planning	38%	35%	**3%**	✔
Microsoft Office	71%	64%	**7%**	✔
Communication skills	80%	85%	**-5%**	✔
Contract management	78%	70%	**8%**	✔
Concept development	48%	49%	**-1%**	✔

If any one skill has an intensity gap[2] larger than 15%, then the skills of a Civil Engineer are not considered 'portable' into Architecture roles

[1] Skill 'intensity' refers to the proportion of job ads demanding the skill.

[2] Skill intensity gap = (Skill intensity for Civil Engineer) – (Skill intensity for Architect)

THERE ARE 7 NEW JOB CLUSTERS IN AUSTRALIA

The job switching and leapfrogging that we observe in today's workforce is not random: individuals move between roles that are related and which build on our prior skills and expertise. But this reality isn't always reflected in the way that young people are encouraged to think about their working lives. Instead, we ask young people to visualise their 'dream job' and pick an often narrow training option. Rather than making study and work decisions based on a narrow concept of a lifelong occupation, we could encourage young people to think about the broader direction of work type they want to perform and to build a portfolio of skills that give them a wide range of options.

In choosing a career, a young person could therefore think not just about their first job but about the cluster of roles that it might open up. There are 7 job clusters in Australia's workforce (Exhibit 2), namely 'The Generators', 'The Artisans', 'The Carers', 'The Coordinators', 'The Designers', 'The Informers' and 'The Technologists'.

'The Artisans'

'The Designers'

'The Generators'

'The Informers'

'The Technologists'

'The Coordinators'

'The Carers'

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[11] Carnevale et al "Understanding online job ads data" (April 2014) Georgetown University, Center on Education and the Workforce

[12] These skills have been selected from a list of 160 enterprise skills that were analysed. A longer list is provided in the Appendix.

Exhibit 2: There are 7 job clusters in the Australian economy, based on skills demanded by employers

These job clusters each currently comprise a variety of occupations, ranging from 10 up to 140 occupations depending on the particular cluster.[12]

	Comprises jobs that...	Occupations currently in this job cluster
'The Generators'	...require a high level of interpersonal interaction in retail, sales, hospitality and entertainment.	**Total:** 65 **Includes**: sales representatives, retail supervisors, cafe managers, hotel managers, bank managers, entertainers, interpreters and airline ground crew. **Industries closely linked with this job cluster include:** Tourism, Retail & Wholesale Trade, Accommodation & Food Services, and Arts & Recreation Services.
'The Artisans'	...require skill in manual tasks related to construction, production, maintenance or technical customer service.	**Total:** 118 **Includes**: machinery operators, landscape gardeners, electricians, crop & livestock farm workers, plumbers, and carpenters. **Industries closely linked with this job cluster include:** Construction, Agriculture, Mining, Manufacturing, Utilities and Logistics.
'The Carers'	...seek to improve the mental or physical health or well-being of others, including medical, care and personal support services.	**Total:** 131 **Includes**: GPs, social workers, childcare workers, fitness instructors, surgeons, counsellors and beauty therapists. **Industries closely linked with this job cluster include:** Health Care & Social Assistance
'The Coordinators'	...involve repetitive administrative and behind-the-scenes process or service tasks	**Total:** 59 **Includes**: bookkeepers, printers, fast food cooks, bus drivers, furniture removalists, law clerks, receptionists and car park attendants. **Industries closely linked with this job cluster include:** Administrative Services and Logistics.
'The Designers'	...involve deploying skills and knowledge of science, mathematics and design to construct or engineer products or buildings.	**Total:** 70 **Includes**: architects, electrical engineers, clothing patternmakers, food technologists, building inspectors, product testers, industrial engineers, geologists and draftspersons. **Industries closely linked with this job cluster include:** Architectural, Engineering & Technical Services.
'The Informers'	...involve professionals providing information, education or business services	**Total:** 142 **Includes**: primary and secondary school teachers, economists, intelligence officers, accountants, policy analysts, solicitors, organisational psychologists, museum curators, and HR advisers. **Industries closely linked with this job cluster include:** Professional, Scientific & Technical services and Education & Training.
'The Technologists'	...require skilled understanding and manipulation of digital technology.	**Total:** 10 **Includes**: programmers, software engineers, database administrators, web designers and ICT business analysts. **Industries closely linked with this job cluster include:** Computer System Design & Related Services and Information Media & Telecommunication Services.

[12] Occupations are reported at the 6-digit level, which is the most granular level of occupations. There are >1000 occupations in the current ANZSCO classification system at this level.

*The Technologists comprises occupations that require a high level of skill in building and manipulating digital technology. The high intensity of the technical skills requested in this job cluster occurs in only a small number of occupations.

What does this strong relationship between jobs mean for a young person? Given the overlap in skills demanded by employers, a young person could think about the cluster of work they want to move within rather than which of the economy's 1000+ jobs they want.

When making this decision, a young person can consider the job cluster that best fits their interests and strengths and test this view by gaining work experience through early-career roles that employers often offer to young people.

2.1 Finding a job cluster that best matches a young person's interests and strengths

A young person can reflect on which of the job clusters best match their interests and strengths. Usefully, each of the 7 clusters of work comprise a list of jobs and skills that employers value most. For example, 'The Informers' job cluster comprises jobs that involve tertiary-educated professionals providing information, education or business services. The 142 jobs in this job cluster include primary and second school teachers, intelligence officers, accountants, policy analysts, solicitors and HR advisers. The skills most commonly requested by employers include data analysis, report writing, financial analysis, risk management and policy development, as well as skills related to teaching and curriculum development.

Young people can use jobs (Section 2) and skills most commonly requested in a job cluster (Section 3) to help them identify the best fit with their passions, interests and strengths.

2.2 Gaining early-career experience in a job cluster

Young people can test their fit within a job cluster and gain crucial experience early in their careers through specific jobs that employers offer more frequently to young people (Exhibit 3). The skills gained in this work experience can be used to lay good foundations in the core skills requested in a job cluster and help to expose young people to other potential roles that might be of interest to them. Rather than seeking casual or part-time work in retail or hospitality, for example, a young person who is considering their options could test their interest and build some of the core skills required in a job cluster through an early-career role in that cluster (See case study: An example of early-career experience in a job cluster...) Young people can either remain in these roles or add the additional skills required to progress to different roles through formal and on-the-job training.

There are a number of early-career experiences that employers commonly make available to young people[13] across each of the job clusters, which help young people to get their 'break' in the job cluster and pick up valuable cross-cutting skills early in their working lives:

Exhibit 3: Example early career occupations in each job cluster

'The Generators': Young people often gain early career experience in this job cluster through roles like sales assistant, autoglazier, telemarketer, retail supervisor, kitchenhand, sports coach or instructor and shelf filler.

'The Artisans': Young people often gain early career experience in this job cluster through roles such as carpenter, roof tiler, mining support worker, drainer, electrician, plumber, air-conditioning & refrigeration mechanic, and motor mechanic.

'The Carers': Young people often gain early career experience in this job cluster through roles such as dental assistant, childcare worker, veterinary nurse, beauty therapist, and fitness instructor.

'The Coordinators': Young people often gain early career experience in this job cluster through roles such as bar attendant, office cashier, service station attendant, and fast food cook.

'The Designers': Young people typically often gain early career experience in this job cluster through roles such as civil engineering draftsperson, quantity surveyor, metallurgist, industrial designer, structural engineer, and civil engineer.

'The Informers': Young people often gain early career experience in this job cluster through jobs like recruitment consultant, event organiser, bank worker, PR professional, statistical clerk, marketing specialist, private tutor, and multimedia designer.

'The Technologists': Young people often gain early career experience in this job cluster through roles like web developer, web designer and web administrator.

Understanding the types of jobs that employers typically offer to young people can help young people gain valuable early career experience, which will enable them to pick up some of the core skills required to move within a job cluster.

[13] Roles specified in this list have a disproportionately high proportion of young people compared to the average across the workforce. Source: ABS Detailed Labour Force.

An example of early-career experience in a job cluster...

Isabelle is taking a gap year and is thinking about what to do next. She is interested in a job within 'The Carers' cluster of work but isn't sure about the specific role. She enrolls in a health sciences study program and decides to gain some work experience as an assistant at the local dental surgery, and quits her casual waitressing job. This role exposes her to the medical industry, gains her valuable skills in patient care and requires her to become comfortable with personal hygiene. She also builds a number of the relevant enterprise skills that are most commonly demanded in 'The Carers' cluster of work such as communication, training, customer service, team work and time management skills. Isabelle doesn't want to remain in the dental profession but uses these experiences to gain skills and references that help her eventually take a role as a speech pathologist.

JOB CLUSTERS REQUIRE SIMILAR SKILLS THAT ARE OFTEN PORTABLE ACROSS OCCUPATIONS

In order to enter, succeed and move around in a job cluster, young people will need the relevant technical and enterprise skills. Young people will likely require a combination of formal training, on-the-job training and experiential learning to develop both the specific technical skills, such as JavaScript, CAD or forklift operation, and the most highly-demanded enterprise skills, such as team work, creativity or problem solving.

3.1 Some technical skills are requested in multiple jobs within a cluster

We often think of technical skills as specific to a particular job or task, such as surgical skills if you are a veterinarian or JavaScript if you are a computer programmer. However,

online job advertisements reveal that many technical skills appear across multiple occupations in a job cluster and are not just specific to a single job. While these skills can vary in difficulty and the amount of training required, employers list all these skills in job advertisements rather than focusing only on the most intensive. The most common technical skills currently demanded by each job cluster are summarised in Exhibit 4.

A specific job will often still require a specific technical skill or subject matter expertise, but picking up many of the core technical skills in a job cluster will enable young people to move across the job cluster and to more easily shift into the unknown jobs of the future within it. Appendix A.2 comprises more detailed lists of technical skills requested within each job cluster.

Exhibit 4: What formal training and technical skills are most commonly requested by employers?

Job cluster	The cluster focuses on skills related to...	Technical skills commonly requested in the cluster:
'The Generators'	generating sales and	• Business development and sales support, managing sales relationships, customer relationship management, contract management
	front of house retail or hospitality services	• Store management, merchandising, stock control
'The Artisans'	generic manual functions	• Workplace health and safety, machinery operation, first aid, inspection, contract management
	as well as specific technical skills	• Forklift operation, hand and power tools operation, welding, plumbing, carpentry
'The Carer'	generic patient or client services	• Screening, first aid, patient care, cleaning, occupational health & safety, data entry, case management
	as well as specific technical skills.	• Clinical experience, rehabilitation, child protection, psychology, therapy
'The Coordinators'	administrative tasks and	• Data entry, contract management, word processing, invoicing, scheduling
	back-of-house functions	• Food safety, cooking
'The Designers'	broadly applicable skills	• Contract management, procurement, inspection business process, scheduling
	as well as more specific technical skills	• Civil engineering, concept development, construction management, estimating, computeraided design
'The Informers'	content required to provide education or business advisory services	• Data analysis, report writing, financial analysis, risk management, policy development
	as well teaching related skills	• Curriculum development, lesson planning
'The Technologists'	programming and IT software development	• Java, SQL • Sharepoint, Adobe Photoshop and website development

3.2 Key enterprise skills appear across multiple jobs within a job cluster

What are enterprise skills?

Enterprise skills are transferable skills that enable young people to engage with a complex world and navigate the challenges they will inherit. Enterprise skills are not just for entrepreneurs; they are skills that are required in many jobs. They have been found to be a powerful predictor of long-term job success. The terms used to describe these skills vary across different contexts: sometimes called generic, soft, or 21st century skills.

While there are some enterprise skills that are commonly sought across job clusters, such as communication skills, writing, training others, digital literacy and problem solving, employers in different clusters of work demand some enterprise skills more often than others.[14] For example, The Artisans job cluster focuses primarily on the capacity to train others, problem solve and manage time, whereas The Informers job cluster requests skills related to writing, problem solving, research, creativity and team work. Interestingly, digital literacy is demanded across most job clusters, as it a core transferable skill but demanding technical skills related to building information technology form part of the Technologists job cluster.

Currently, the enterprise skills most demanded by job cluster are summarised in Exhibit 4.

Exhibit 5: What enterprise skills are most commonly demanded by employers?

Job cluster	The cluster focuses on skills related to...	Enterprise skills commonly requested in the cluster:
'The Generators'	customer service and	• Communication skills, building effective relationships, customer service
	organisational skills	• Planning, time management, digital literacy
'The Artisans'	organisational skills and	• Detail-orientation, planning, problem solving, digital literacy
	interaction skills	• Capacity to train others, communication skills, team work
'The Carer'	Interaction skills,	• Communication skills, team work, teaching, customer service
	problem solving and	• Problem solving, research
	organisational skills	• Planning, time management, detail-orientation
'The Coordinators'	organisational skills and customer service	• Time management, detail-orientation, digital literacy
		• Communication skills, team work, customer service
'The Designers'	problem solving and	• Problem solving, digital literacy
	project management skills	• Planning, Quality assurance, project management, time management
'The Informers'	interaction skills,	• Communications skills, written communication, teaching
	problem solving and	• Problem solving, creativity, research
	detail-orientation skills	• Detail-orientation, project management, digital literacy
'The Technologists'	interaction skills and	• Communication skills, customer services, team work,
	detail-orientation skills	• Detail-orientation, planning, quality assurance, project management

The set of core technical and enterprise skills outlined for each job cluster in this report can be used by young people to identify the types of courses they might want to enroll in or work experience they might want to acquire. Likewise, educators and policy makers could use these lists to help design the offerings that are core to multiple curricula.

[14] Demand for a given skill across a job cluster is observed by the fraction of occupations in that job cluster where the skill is within the top-20 demanded by employers (as measured by the proportion of job ads requesting the skill).

SOME JOB CLUSTERS HAVE STRONGER FUTURE PROSPECTS

As technology transforms the way we live and work, young people don't only need to consider what job is right for them; they also need to think about whether that job will still be around in twenty or thirty years time. Recent studies have shown that approximately 40% of jobs that exist today have a high probability of being affected by automation in the next 10-15 years.[15] While it is helpful to understand the current labour market, young people in Australia also need information about the labour market of the future, to help guide the decisions they need to make about about training, skill development and entry-level job applications.

Each of the 7 job clusters have different future prospects, with some offering greater long-term security than others on average. To understand the future prospects of each job cluster, we ranked them based on their likely future growth[16] and resistance to automation.[17] There are obviously other forces that will affect the future prospects of jobs, including megatrends related to demographics, sustainability and changing economic dynamics in Asia.

Within each cluster there are jobs that will be resilient and others that are more likely to be affected by automation.

Some clusters of work have more of the resilient jobs because the skills that are commonly requested are more resilient to automation. Of the 7 job clusters: 'The Artisans' and 'The Coordinators' are likely to experience lower growth and high exposure to automation; 'The Generators' and 'The Designers' are likely to experience moderate growth and medium exposure to automation; and 'The Carers', 'The Informers', and 'The Technologists' are most likely to grow and persist into the future. Over time, the jobs that comprise these clusters of work will change, as will the names and number of clusters of work. Additional job clusters may arise, based on new occupations and new skills being demanded and valued by employers (Exhibit 6).

However, irrespective of the different prospects for job clusters as a whole, there are jobs within each cluster of work that have stronger future prospects. Young people could target the specific roles that are most likely to grow.

In addition to picking a job cluster that matches best with their passions, interests and strengths, a young person could ensure their choice has good future prospects or that they navigate through the job cluster via roles that are likely to grow in the next 10-15 years.

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[15] CEDA (2015) 'Australia's Future Workforce', Chapter 1.4.

[16] Total five-year job growth for occupations within a job cluster, measured over the period 2010 to 2015. Source: ABS. See Appendix A.3 for a detailed methodology.

[17] Probability that the occupation will be affected by automation over the next 10-15 years. Source: Data provided by NICTA, as reported in CEDA (2015) 'Australia's Future Workforce', Chapter 1.4. See Appendix A.3 for a detailed methodology.

Exhibit 6: Which job clusters have the strongest future prospects?

Clusters	Growth and Automation	Future Prospect	Example jobs within the cluster that have strong future prospects (occupations grew 2010-2015 and risk of impact of automation is <70%)		
'The Generators'	Job Growth (2010-15) **7.4%** Affected by automation **45%**	Moderate	ICT sales reps Retail supervisors Café or restaurant managers Call centre team leaders	Entertainers & variety artists Hospitality managers Sports instructors Bank managers	
'The Artisans'	Job Growth (2010-15) **5.6%** Affected by automation **77%**	Weak	Carpenters & joiners Landscape gardeners Electrical engineering technicians Mechanics Upholsterers Electricians		
'The Carers'	Job Growth (2010-15) **18.0%** Affected by automation **26%**	Strong	General practitioners Nurses Podiatrists Dental technicians Health promotion officers Pharmacists Veterinarians Radio-graphers Physio-therapists	Tour guides Beauty therapists Make-up artists Community health workers Massage therapists Cardiac technicians Anaesthetic technicians Childcare workers	Special education teachers Fitness instructors Emergency service workers Psychiatrists Paramedics Surgeons Social workers Occupational therapists
'The Coordinators'	Job Growth (2010-15) **3.0%** Affected by automation **71%**	Weak	Receptionists Travel attendants Florists ICT support technicians Admissions clerks		
'The Designers'	Job Growth (2010-15) **13.1%** Affected by automation **43%**	Moderate	Construction project managers Civil engineers Computer network & system engineers	Project administrators Electrical engineers Architects Industrial engineers Geologists	Mining engineers Landscape architects Food technologists
'The Informers'	Job Growth (2010-15) **7.6%** Affected by automation **36%**	Strong	Policy analysts Statisticians Physicists Gallery or museum curators Economists Laboratory managers Human resource advisers	OH&S advisers Financial brokers Solicitors Technical writers Actuaries Detectives Organisa-tional psychologists	Market research analysts Journalists Primary & secondary school teachers
'The Technologists'	Job Growth (2010-15) **19.0%** Affected by automation **50%**	Strong	Programmers Software engineers Web developers Database administrators Web designers	**New Cluster?**	Additional job clusters may arise, based on new occupations and new skills being demanded and valued by employers

* Refer to Appendix A.3 for further detail

This report continues our national conversation on how to reconceptualise the future of work. So much of the existing information available to young people paints an incomplete picture: lists of the top 10 jobs of the future, the industries or roles that are predicted to grow most quickly, or the advanced digital skills they will require.[18] Instead, big data can be used to inform young people, educators and parents about the skill patterns, or footprints, that exist in our labour market and will persist into the future.

By conducting analysis of the skills requested in millions of job advertisements, it is clear that conversation about work needs to progress beyond the 1000+ occupations that comprise the economy. For the first-time we can demonstrate that:

- Young People are skilled for more jobs than they realise: in fact, when a person trains or works in 1 job, they become skilled for 13 other jobs on average.

- There are 7 job clusters in the Australian economy. Young people can use the typical jobs and skills requested in a cluster to identify their best fit and can test this fit with early-career job opportunities in the cluster.

- Employers value numerous common technical and enterprise skills within a job cluster.

- Some job clusters have more promising future prospects than others.

By thinking of skills as portable across many roles and thinking of jobs as part of 7 clusters, rather than as 1000+ isolated occupations, a number of potential implications arise for parents, young people, educators, employers and policy makers.

For young people:

Young people can think of the types of related jobs that fit their interests and strengths and discover the core skills required for those jobs. Decisions about training and work experience can be guided by the core skills that young people need to acquire to succeed in a job cluster.

For employers and recruiters:

Employers and recruiters could consider a wider breadth of potential candidates, from other occupations with similar skills, when recruiting for positions. This will widen the pool of candidates and may help to both reduce vacancies and drive better labour-market matching.

For educators:

University, VET and TAFE providers could consider designing curriculum to support the core skills requested in each job cluster.

Course information could better identify the many different jobs that specific courses prepare young people for, rather than single occupations.

For policy-makers:

Policy-makers need to map skills by occupation and group occupations with a high overlap of skills (similar to the methodology outlined in this report) and make this information accessible and routinely updated.

Policy-makers and educators need to ensure that young people are equipped with the skills required to manage multiple shifts in jobs, lifelong learning and iterative skill acquisition.

For careers advisers:

Careers advisers could present information differently to include: The clusters of work; the breadth of jobs available to a young person given a particular skill set; and the one or two additional skills required to switch from one job to another job.

For parents:

Parents could view some of the job and training switches made by their children as part of gaining the core, portable skills required to move within a job cluster.

No matter how the discussion progresses, the continued dynamism of work highlights the need for young people to be well equipped with the skills required to manage their careers and their lifelong learning.[18] The New Work Mindset is here. We have an exciting opportunity to recast the uncertain future of work as an opportunity for young people to develop a skill portfolio of skills they will deploy across a coherent set of roles.

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[18] CICA defines career management skills as the capacity to "identify their existing skills, develop career learning goals and take action to enhance their careers." https://cica.org.au/wp-content/uploads/Understanding-career-management-skills-Final-Feb-2016.pdf

APPENDIX

A.1 Limitations of current skills information and reporting

In the context of uncertainty, it is not easy to make decisions if you are a teacher or student today. Amid the growing discussion about automation, globalisation, flexibility and the jobs of the future, it is challenging to know what to teach, what to choose to study, or where to apply for your first job. This is not because there is an information vacuum. Instead the difficulty with making good decisions arises, in part, because existing information and reporting on jobs growth and the jobs of the future face a number of limitations. Existing information and reporting typically focuses on:

1. Top occupations or skills that are expected to be in high demand, such as web developers, data analysts, physical therapists and aged care professionals.

- These types of lists are helpful for an education provider thinking about the specific courses they should offer or boost available places, or a student thinking about the courses they should enroll in to guarantee employment in the near term.

- However, these lists fail to help an educator understand the core skills that need to be taught across courses or the breadth and mix of courses that should be offered.

2. Advanced, digital skills that will be required for the future, such as 'computational thinking', 'new-media literacy', 'design mindset' and 'virtual collaboration'.

- These shortlists of skills help education providers think about some of the key skills of the future, especially digital skills, which should be incorporated into some courses.

- However, these lists are often unduly narrow and reflect a small (albeit exciting and growing) proportion of jobs and skills required to participate in the broader economy.

3. Industries of the future in Australia, such as tourism, international educational, health and aged care, and professional services.

- Helpfully, these lists of attractive future industries provide a picture of the Australian economy in the future.

- But such a picture does not assist educators or students with an understanding of the skills required to participate in that industry. Jobs across industries are very heterogeneous in their skill requirements e.g. health covers jobs as different as a blood collector, surgeon and hospital administrator.

Given these challenges, we believe it is worth supplementing the existing lists of top occupations, skills and industries with different insights based on this first-time analysis of clusters of skills into job clusters. In order for skills information to be most helpful for policy makers, educators, students and parents, it should meet four principles:

- Applies to whole-of-workforce: Reflects the skills required across the whole economy, rather than for select or niche occupations

- Reflects dynamism of working lives and lifelong learning: Recognises that working lives are most likely to be broader than a single occupation and involve multiple career shifts, which often draw on similar skills. Reflects the concept of lifelong learning

- Encompasses all types of skills: Holistically represents skill requirements as comprising both technical and enterprise skills

- Applies now and in the future: Reflects skill requirements today and in the future

Exhibit A.1 (i)

Skills information should meet four principles		
Principles for skills information		**New insights from new methodology**
A Applies to whole-of-workforce	• Reflect all jobs, rather than roles with an unrepresentative set of jobs • Reflect the skills required across the whole economy, rather than for select or niche occupations	• Generates distinctive clusters, reflecting the diversity of career preferences • Analyses >600 occupation codes across the whole economy
B Reflects dynamism of working lives and lifelong learning	• Recognise that working lives are often broader than a single occupation and involve multiple career shifts, which often draw on similar skills • Reflects concept of lifelong learning and development of related skillsets	• Groups occupations into clusters by skill, in recognition that not all workers follow a single occupation path but instead utilise their skills across fields
C Encompasses all types of skills	• Holistically represent skill requirements as comprising both technical and enterprise skills	• Both technical and enterprise skills are analysed and grouped in combinations that employers demand
D Applies now and in the future	• Reflects both current skill demands and skills that will be needed in the future	• Analyses skills demanded by employers today and the skill requirements likely to remain in growth occupations that are less vulnerable to automation

[19] For example, see http://www.forbes.com/sites/kathryndill/2015/11/09/the-20-occupations-with-the-strongest-growth-this-year/#7f4456403ff3 or https://blog.linkedin.com/2016/01/12/the-25-skills-that-can-get-you-hired-in-2016

[20] For example, see http://www.iftf.org/uploads/media/SR-1382A_UPRI_future_work_skills_sm.pdf

[21] For example, see http://www.mckinsey.com/global-locations/pacific australia/en/latest-thinking/compete-to-prosper

A.2 Detailed Methodology – Developing job clusters

1. Skills data was collected for all unique occupations over the two most recent financial years (FY15 & FY16, i.e. July 2014 to June 2016) using online job advertisements, including data from Burning Glass.

- Occupations are defined at the 6-digit level, as per the latest ANZSCO classification (2013)

- For statistical reliability, only occupations with at least 50 job ads over the 2-year period were included

- For each of the unique occupations satisfying this criterion (625), the number of skill references in job ads were then analysed

- Skills demanded are categorized as either:

    - Enterprise skills (highly transferable – e.g. communication skills or leadership)

    - Technical skills (skills that typically require formal or on-the-job training specific to a task – e.g. SQL coding, forklift operation, visual merchandising, or surgery)

2. The *intensity* of demand for each skill in a given occupation was then evaluated.

- The intensity of a skill *i* (where *i* = 1st, 2nd, ..., nth skill) for a given occupation *j* (where *j* = 1st, 2nd, ..., 625th occupation) is defined as follows:

> Intensity $_{i,j}$ =
> (Total mentions of skill $_i$ by job ads in occupation $_j$) /
> (Total job ads in occupation $_j$)

3. A *dissimilarity* score was then constructed between each pair of occupations, based on the intensity of skill mentions for each occupation.

- Skill intensities for all 625 occupations were compared against each other – a total of 195,000 pairwise occupation skill comparisons

- For each occupation within a pair, the total demand for all skills was analysed to determine the *intensity* of that entire set of skills (as per above equation)

- For each skill in an occupation pair, the squared 'distance' (d_i^2) between the two occupations in the intensity of demand for that skill was then calculated.

By way of illustration, for a given pair of occupations *j* = 1, 2 and a total set of 5 skills

i = 1, 2, ..., 5:

d_1^2 = Squared 'distance' for Skill 1 = (Intensity$_{1,j=1}$ – Intensity$_{1,j=2}$)^2

Skills i:	Intensity in Occupation 1	Intensity in Occupation 2	Squared distance of skill intensities:
1	Intensity $_{1,1}$	Intensity $_{1,2}$	$d_1^2 = (Int._{1,1} - Int._{1,2})^2$
2	Intensity $_{2,1}$	Intensity $_{2,2}$	$d_2^2 = (Int._{2,1} - Int._{2,2})^2$
3	Intensity $_{3,1}$	Intensity $_{3,2}$	$d_3^2 = (Int._{3,1} - Int._{3,2})^2$
4	Intensity $_{4,1}$	Intensity $_{4,2}$	$d_4^2 = (Int._{4,1} - Int._{4,2})^2$
5	Intensity $_{5,1}$	Intensity $_{5,2}$	$d_5^2 = (Int._{5,1} - Int._{5,2})^2$

- A dissimilarity score for each pair is then calculated by aggregating (summing) the squared skill intensity 'distances' between the occupations for each skill, and taking the square root:

Skills, *i*:	Squared distance of skill intensities:
1	$d = (Int._{1,1} - Int._{1,2})^2$
2	$d_2^2 = (Int._{2,1} - Int._{2,2})^2$
3	$d_3^2 = (Int._{3,1} - Int._{3,2})^2$
4	$d_4^2 = (Int._{4,1} - Int._{4,2})^2$
5	$d_5^2 = (Int._{5,1} - Int._{5,2})^2$
Dissimilarity score ($D_{j=1,2}$) for occupations 1, 2:	$D_{j=1,2} = \sqrt{(\sum d_i^2)} = \sqrt{(d_1^2 + d_2^2 + d_3^2 + d_4^2 + d_5^2)}$

- This process is repeated for all 195,000 occupation pairs, generating a dissimilarity matrix for all occupations:

Occupation:	Occp. 1	Occp. 2	Occp. 3	...	Occp. 625
Occp. 1	$D_{j=1,1}(= 0)$	$D_{j=1,1}$	$D_{j=1,3}$	...	$D_{j=1,625}$
Occp. 2	$D_{j=2,1}$	$D_{j=2,2}(= 0)$	$D_{j=2,3}$	...	$D_{j=2,625}$
Occp. 3	$D_{j=3,1}$	$D_{j=3,2}$	$D_{j=3,3}(= 0)$	...	$D_{j=3,625}$
...	...	...	...	...	...
Occp. 625	$D_{j=625,1}$	$D_{j=625,2}$	$D_{j=625,3}$	...	$D_{j=625,625}(= 0)$

4. The *k-means clustering algorithm* was then applied to occupation using the skill intensity dissimilarity scores:

- The number of sub-clusters, k, was specified as k = 20

- A balance was required between specifying too many vs. too few clusters:

    - If specifying too few sub-clusters, the algorithm will group occupations that are relatively close but in reality are quite distinct

    - If specifying too many sub-clusters, then the final clusters depend too heavily on human judgment to be grouped together

    - By starting with a larger set of distinctive sub-clusters, and working backwards to 6-8 clusters, we can arrive at a sensible set of final clusters

- After specifying k = 20, the algorithm partitions the 625 occupations into 20 sub-clusters such that the sum of the squared distances between the centroid (the centre of a sub-cluster) and everything within the sub-cluster is minimised

  - The centroid is identified by an iterative process/algorithm

5. This generated 20 sub-clusters:

- 4 sub-clusters (containing only 21 occupations) were eliminated due to insufficient size;

- 16 sub-clusters (containing 604 occupations) remained, providing a whole-of-economy breadth

6. The 16 remaining sub-clusters were then manually sorted into the final set of clusters

- 'Adjacent' sub-clusters, i.e. those with similar skill requirements, were merged

- 7 distinct final clusters were found and termed 'job clusters'

7. Top enterprise & technical skills in a job cluster were determined as follows:

- Top skills for each occupation were generated and ranked using skill intensity data (calculated earlier – see above), i.e. the fraction of job ads in the occupation that referred to a given skill;

- Within each job cluster, the proportion of occupations for which a given skill was among the top-20 demanded in job ads was calculated;

- Top skills for a job cluster were then generated and ranked using this proportion of occupations within the job cluster where the skill was among the top-20 demanded.

A.3 Detailed Methodology – Developing occupations of the future

1. To arrive at Occupations of the Future, two broad filters were applied to a whole-of-economy list of occupations: employment growth and susceptibility to automation over the medium-to-long-term. This report seeks to avoid playing the role of futurist; it does not predict the state of the economy or technology over the very long-term. While such variables are relevant to employment outcomes over the longer-run, this report recognises that attempts to predict different future universes belong to the realm of speculation rather than analysis.

2. Capturing a breadth of occupations with reasonably strong future prospects was an important objective of this report's analysis. In pursuit of that objective, the deliberate choice was made to set filters at only moderate thresholds. The report thereby avoids focusing on a narrow set of the fastest-growing jobs or skills (e.g. Nesta (2016)), or only on jobs that are invulnerable to any impact from automation.

- The first filter tests for whether employment grew over the last 5 years (i.e. between 2010 and 2015). This will include some occupations where job growth is modest and has been outpaced by broader labour force growth or population growth;

- However, by *excluding* roles in a contraction phase this method aims to capture occupations that will continue to provide a meaningful level of job openings (and therefore meaningful opportunity for young Australians);

- The historical period of 2010 to 2015 was selected due to its recency; overall similarity in employment rates in 2010 and 2015; and avoiding distortionary trends that would emerge if more recent data was used (e.g. starting from the peak of the mining boom around 2012/13) or older data was used (e.g. starting in the GFC of 2008/09, or in the economic boom preceding it)

3. The second filter tests for whether an occupation's vulnerability to automation over the medium-to-long-term is too high.

- Automation risk data obtained from NICTA developed for CEDA (2015) report *"Australia's Future Workforce"* Chapter 1.4

- Consistent with the CEDA report, this filter used the criterion that a probability of being impacted by automation over the next 10-15 years at 70% or more is 'high'.

  - Approximately 43% of all occupations classified have a risk of being impacted by automation that exceeds this threshold

  - Vulnerability is modelled on the presence of difficult-to-automate job characteristics such as creativity, manual dexterity, or persuasion skills

4. Note that for both filters, information is only specific up to the 4-digit level. Thus, we are using 4-digit employment growth and automation risks to classify 6-digit occupations.

- There are 474 different 4-digit occupation unit groups, compared to 1352 occupations at the 6-digit level

- This means that, on average, there are approximately 2.85 occupations at the 6-digit level within a 4-digit occupation unit group

- While the accuracy of employment growth data or automation risk data is limited to the 4-digit level, this remains a strong proxy for 6-digit occupations given that:

  - The 474 occupation unit groups (4-digit level) separates occupations into highly specific, distinctive groupings;

  - Occupations (6-digit level) within each of these unit groups are very close to one another in terms of skills required and nature of the role;

  - Due to the screening criteria (at least 50 job ads over 24 months), the 625 occupations (6-digit level) represent the bulk of the weight of the 4-digit occupations

A.5 Detailed Methodology – Portability of occupations

1. To construct the portability measure, the following analysis was conducted for every possible pair of occupations, assessed in both directions (390,000 calculations).

- To assess the portability of an occupation i, let any given pair be denoted as occupations i and j

- A list of all unique skills appearing in job ads for either of the two occupations is then constructed

  - Every occupation has a skill 'intensity' for each unique skill, i.e. the fraction of job ads within that occupation which demand the skill

  - For skills that do not appear in either occupation, the 'intensity' of the skill is 0

2. Similarity in intensity of demand for a given skill x is assessed by subtracting occupation j's intensity of skill x from occupation i's.

- This calculation is then performed between all occupations for all skills.

  - If skill x is demanded more frequently by jobs in occupation i than in occupation j, then this difference will be positive

  - If skill x appears more frequently in jobs in occupation j than in occupation i, then the difference will be negative

- If these differences were all positive, then it means that occupation i can subsume occupation j, since all skills in occupation j are demanded with greater intensity in occupation i

  - This is never the case, and for this reason a less stringent rule is used to determine portability

3. A rule to define 'portability' from any occupation i into any other occupation j was developed.

- The portability of occupation i is defined as having no skill where the difference in skill intensity between occupations i and j is less (more negative) than -0.15

  - If even one skill has an intensity difference which is less (more negative) than -0.15 between occupations i and j, then occupation i is not considered 'portable' into j

4. The -0.15 cut-off has interesting implications for any two occupations i, j whose skillsets are deemed to be 'portable' with one another.

- The cut-off implies that if skill x is demanded by all (100%) of the jobs in occupation j, an individual has at least an 85% chance of acquiring that skill working in occupation i;

  - If skill x appears in half (50%) of the jobs in occupation j, then an individual still has at least a 35% chance of picking it up working in occupation i

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