A Critical Moment

The supply and demand of mining, metallurgical and geotechnical engineers in the Australian resources industry

An AusIMM report

AusIMM

DRAFT REPORT FOR DISCUSSION (v2.0)

About the AusIMM

The Australasian Institute for Mining and Metallurgy (AusIMM) is the peak body for resources professionals, with over 13,000 members across more than 110 countries. Established in 1893 and operating under the Royal Charter, we represent professionals across all levels of the mining industry, working from exploration through to delivery and in disciplines ranging from mining engineering to geoscience, health and safety, finance, Government, and academia.

We lead the way for people in resources, supporting professionals to provide enduring benefits for the community. We are committed to upholding ethics, codes and standards in resources and delivering the highest quality of professional development to the sector.

As the trusted voice for resources professionals, we exercise shared leadership to benefit our sector and in the interest of all members of the global community. We advance our sector's continued technical and professional leadership on the world stage, champion community understanding and support for the industry, and work with governments to design, implement and maintain regulatory frameworks that facilitate the continued economic and social contributions delivered through mining.

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Executive summary

AusIMM's Working Group on the *Resources Industry Future Workforce* has identified that a shortfall in the supply of graduate engineers exists and is worsening. In developing this report, the Working Group has examined the challenges facing the industry's future workforce, specifically relating to its talent pipeline. To best understand these challenges, the focus of this report is on mining, metallurgical and geotechnical engineer job roles.

This report comprises three key areas of enquiry:

An overview of previous research – Previous research has identified that whilst some solution-oriented discussion and initiatives have occurred, largely the same issues presented 20 years ago are still present now. Some new issues have also emerged in that time. Four key themes emerged from the previous thought leadership pieces that were examined, namely:

- **The benefits of alignment between university offerings and the needs of employers.** The strong perception is that graduates are well trained theoretically and technically. However, other aspects of job readiness may need to be more strongly included such as 'people skills' and practical experience.
- **Greater collaboration needs to be encouraged in the university sector.** In the past, there have been positive outcomes from initiatives that encourage university collaboration. However, the university business model is seen as a barrier, given the way universities are incentivised encourages competitive behaviour over collaboration.
- **Micro-credentialing and alternative pathways present opportunities to create additional entry points into these job roles.** These are generally targeted short courses that offer an alternative pathway into job roles from other professions. Micro-credentials can, therefore, broaden the talent pool and reduce barriers to entry. Another popular alternative are associate degree programs which can provide significant practical experience. While increasing utility, some have cautioned that quality must not be comprised by introducing new pathways.
- **Greater government participation** is needed to work with all stakeholders to solidify the future of mining. Challenging issues include an emerging anti-mining perception and changes to school curricula. Governments are seen to have a key role to play in supporting universities with targeted initiatives and spreading awareness of the industry's central role in the transition to a clean economy future.

Demand and supply forecast scenarios – Forecasting conducted as part of this report shows an increasing disconnect between employment demand and supply of graduates over time. Where the National Skills Commission (NSC) forecasts strong growth in all three occupations to 2025, the Working Group sought to forecast demand out to 2040. To account for industry variables, forecasts were developed against four scenarios:

- Upside scenarios for both coal and minerals demand;
- Upside scenario for coal demand, downside for minerals;
- Upside scenario for minerals demand, downside for coal;
- Downside scenarios for both coal and minerals demand.

Forecasting places total employment across the three occupations between 5,623 (worst case) and 7,786 (best case) by 2040.

This is against the backdrop of declining graduate supply. Universities are experiencing a decline in enrolments, reflecting difficulty in attracting people into mining career pathways. This may be explained by a combination of, amongst other factors: shifting public perception of the resources industry, lack of willingness to work regionally, and limited exposure to relevant careers in schools.

This report focuses on graduate supply but acknowledges that a fuller picture of supply would also incorporate other positive supply factors (e.g. skilled migration, upskilling from within the industry) and negative supply factors (e.g. workforce exit, retirement).

Challenges facing universities - Low enrolments, which lead to low graduate numbers, pose a critical challenge for mining engineering programs. This report highlights that the enrolment numbers for university programs are currently at a level that is below the critical mass required to keep those courses sustainable. Without a positive change in these numbers, courses will be closed or absorbed into broader offerings. The report finds that it would be difficult to bring these courses back in the future once they are gone and that would fundamentally impede Australia's ability to develop a domestic talent pipeline.

The reasons for low graduate supply are not all fully controllable by universities and collaboration with industry and government is required to improve numbers.

The findings of this report have led the Working Group to make four key recommendations:

1. **Establish an improved and consistent method for data gathering and reporting:** A significant barrier to effective industry workforce planning in the resources industry is the lack of detailed, accurate and readily available data. Existing relevant data, such as that published by the National Skills Commission (NSC), is not sufficiently detailed, often reporting at the level of job clusters (rather than individual job roles). These data sources also do not easily allow the user to test the impact of various assumptions (e.g. commodity demand) on forecast employment growth.
2. **Encourage greater collaboration between industry and Higher Education:** The closer alignment of these stakeholder groups is critical. Clearer formal channels of communication ought to be established to address the supply issue faced by the industry. Greater collaboration is required in relation to the development of engineering course content, and to promote shared responsibility for progress towards job-ready graduates (e.g. through more opportunities for work-integrated learning).
3. **Conduct targeted public education to foster greater understanding of the resources industry:** Decline in public perception towards the resources industry is largely informed by an incomplete understanding of the breadth of the industry and its contribution to green economy initiatives. Better public understanding may encourage uptake of mining courses, particularly by young Australians.
4. **Invest in alternative and sustainable models of education and pathways into the industry:** Investing in alternative training and education pathways is crucial to relieving pressure on universities, broadening and deepening the talent pool. Reviews into the current alternative pathways, and time spent developing these accreditations, or creating new ones, will help to stem the decrease in graduate supply. A focus on continuous improvement will enable piloting and refinement of alternative approaches.

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1. Introduction

The mining industry has long been a crucial part of Australia's economy, and has been powering Australia's economic recovery from the COVID-19 pandemic through record revenue from exports of iron ore, gold, and copper.[1]

The industry employs 278,800 people (May 2021), with employment growth over the last 5 years of 27.1%.[2] Employment is expected to increase on the back of growing demand for mined materials and strong commodity prices.[3] Demand is predicted to be strong thanks to the expected continuation of iron ore exports to China, and opportunities to supply other East Asian countries with essential commodities.[4]

Despite social attitudes moving away from some mined commodities, such as coal, in the medium to long term future the sector will remain strong to support the global shift to new technology, including playing an essential role in transition to zero-emission technology. With demand growing and job roles evolving, this is creating a significant challenge for employers to access the required number of skilled workers.

Universal circumstances, including a lack of labour mobility and willingness to be located regionally, are negatively impacting the pipeline of workers entering the resources sector. Industry-specific challenges are also affecting supply, such as challenging perception of the industry among young people.

These challenges are strongly evident in engineering occupations: mining engineers, metallurgical engineers, and geotechnical engineers. Using these three occupations as a case study, this report seeks to examine the factors impacting supply and demand, forecast the growing disparity between the two, and identify opportunities to increase supply.

Background to the scope of this report

The Working Group decided to focus on mining engineers, metallurgical engineers, and geotechnical engineers because they believed that these were the professions that required most urgent attention. This does not in any way suggest that issues related to workforce supply and demand are limited to these professions. In fact, the factors impacting these professions outlined in this report could reasonably be applied to many professions requiring university level qualifications in the resources sector.

Mining engineers

Mining engineers are minerals specialists, who are involved in the entire mining cycle. Their roles can include assessing land for mineral deposits, and then planning and supervising the extraction of minerals.[5] Many mining engineers are relied on to research techniques to enhance the safety and efficiency of their mines and they are also involved in the closure and rehabilitation of the mined area.[6]

The most common pathway to becoming a mining engineer is obtaining either an undergraduate university degree in engineering with a major in mining engineering, or a Master's degree. Degrees obtained from the University of WA, Monash University, Federation University, University of Wollongong, Curtin University, University of Queensland, University of NSW and the University of Adelaide qualify the individual to work in the statutory positions in the industry.[7] It is possible to obtain a statutory position without a university degree, as long as the statutory requirements are met.

FIGURE 1: UNIVERSITY MINING ENGINEERING COURSES

UNIVERSITY	UNDERGRADUATE QUALIFICATION	DURATION	MASTER'S PROGRAM	DURATION
University of WA	Bachelor of Engineering (Honours)	4 years	Master of Engineering in Oil and Gas	1 - 2 years
	(Double Degree Option)	5 years	Master of Ore Deposit Geology	1.5 years
Monash University	Bachelor of Engineering (Honours)	4 years	–	–
	(Double Degree Option)	5 years	–	–
Federation University	Bachelor of Engineering (Honours) (Mining)	4 years	Master of Engineering Technology (Mining Engineering)	2 years
University of Wollongong	Bachelor of Engineering (Honours) (Mining)	4 years	Master of Engineering (Mining Engineering)	2 years
Curtin University	Bachelor of Engineering (Honours)	4 years	Master of Philosophy (Mining and Metallurgical Engineering)	2 years
	Bachelor of Engineering (Civil and Construction Engineering) / Bachelor of Science (Science) in Mining	5 years	–	–
University of Queensland	Bachelor of Engineering (Honours)*	4 years	–	–
University of NSW	Bachelor of Engineering (Honours) (Mining)	4 years	Master of Mining Engineering	1.7 years
	Bachelor of Engineering (Honours) / Bachelor of Engineering Science	5 years	Master of Mine Geotechnical Engineering	1.5 years
University of Adelaide	Bachelor of Engineering (Honours) (Mining)	4 years	Master of Engineering (Mining)	2 years
	(Double Degree Options)	5 years	–	–
University of Newcastle	Bachelor of Engineering (Mining) Transfer Program**	4 years	–	–

* Must choose either a civil, mechanical, or mechatronic specialisation to major in mining engineering.

** The transfer program involves a 2-year program at the University of Newcastle and then transferring across to either a Bachelor of Civil Engineering (Honours) or to either UNSW or University of Wollongong to complete the Bachelor of Engineering (Mining).

Information sources: NCI – Course Seeker, PostgradAustralia, Monash University website, University of WA website.

1 https://www.minerals.org.au/news/mining-export-revenue-leads-australia%E2%80%99s-economic-recovery
2 "Mining Export Revenue Leads Australia's Economic Recovery," Minerals Council of Australia, accessed on September 13, 2021, https://www.minerals.org.au/news/mining-export-revenue-leads-australia%E2%80%99s-economic-recovery
3 "Regional Industry Data: Mining," Labour Market Information Portal, accessed on September 13, 2021, https://lmip.gov.au/default.aspx?LMIP/GainInsights/IndustryInformation/Mining
4 "Mining Export Revenue Leads Australia's Economic Recovery," Minerals Council of Australia, accessed on September 13, 2021, https://www.minerals.org.au/news/mining-export-revenue-leads-australia%E2%80%99s-economic-recovery
5 "Mining Engineers Help Create Safe and Productive Working Environments," AusIMM, accessed on September 13, 2021, https://www.ausimm.com/insights-and-resources/insights/mining-engineering/
6 "Mining Engineers Help Create Safe and Productive Working Environments," AusIMM, accessed on September 13, 2021, https://www.ausimm.com/insights-and-resources/insights/mining-engineering/
7 Peter Knights, "Australian Graduate Mining Engineering Statistics 2009-2020," SharePoint, (March 2021): 1.

Metallurgical engineers

Metallurgical engineers are also minerals specialists, but their roles focus on how to extract, cast, and separate minerals and metals from their ores. This role is like a mining engineer's role, however, is more heavily focused on the treatment and processes of the metals once extracted from the ground.[8]

Most single discipline metallurgy university courses have been absorbed into chemical engineering courses.[9] Thus, recent graduates entering this role will most likely have completed a Bachelor of Chemical Engineering, or alternatively some may have obtained a Bachelor of Science with a major in metallurgy instead.[10]

Geotechnical engineers

Geotechnical engineers investigate geological structures and geotechnical features of a mine to assist in the mining process. Individuals in these roles are experts on the features and properties of the land the mine is to be built on, as well as predicting ground behaviour.[11] Geotechnical engineers are also involved with geological aspects of the projects such as waste dump construction and placement of backfill.

Students at an undergraduate level formerly completed a degree majoring in geoscience. Prior to 2015, those wishing to obtain an Honours qualification had the opportunity to participate in the Minerals Geoscience Honours (MGH) program, set up by the MTEC.[12] Today, interviewees suggested that there are non-specific pathways to geotechnical engineering such as through undergraduate electives or postgraduate study.

Note: These occupation descriptions might differ in a smaller organisation (when compared with a larger one).[13] Typically, there is a greater degree of specialisation in individual roles where the total number of employees increases. Larger organisations have capacity hire more staff, enabling greater specialisation; smaller organisations tend to have fewer employees, meaning that roles are often required to cover more than one operational function, resulting in greater generalisation.

Creating a pipeline of skilled workers

Without mining, metallurgical, or geotechnical engineers, mining operations cannot effectively function, making it vital that there is a skilled pipeline of workers to occupy these roles. While feedback indicates that engineers from different disciplines can be placed in these roles, interviewees note that this practice is not sustainable because it increases operational risk and reduces productivity. These occupations are therefore crucial to the ongoing prosperity of the industry. Education and training are key pieces of the supply puzzle, alongside skilled migration.

More broadly, the mining industry is critical to the Australia economy. Mining accounts for approximately 2% of Australian jobs[14] and it has proven to be very stable – the Australian Bureau of Statistics (ABS) found that there were almost no job losses during the pandemic in 2020, while national unemployment rose to 6.9%.[15] With the 98 new or expansion projects confirmed to occur up until 2026 employment in mining will increase, having a further positive impact on overall national unemployment.[16]

To ensure the ongoing productivity of the industry, people with the necessary skills to work on these projects are essential. These individuals need specialist training in how to carry out the key functions of the job roles, particularly as these evolve.

Engagement in education and training

AusIMM's Working Group on the Resources Industry Future Workforce has identified that there is already a supply issue and believe that this may continue to worsen over coming years.

The number of mining engineer graduates was slowly rising from 2009 until the peak in 2015 of 333 graduates.[17] This was out of phase with demand as it corresponds to the low points in the Iron Ore market price.[18] Despite market recovery (and the demand for graduates continuously increasing) the supply of graduates has been on a steep decline. The number of graduates dropped most significantly in 2018 where there were nearly 100 less graduates produced than 2017.[19]

FIGURE 2: MINING ENGINEERS GRADUATING FROM FOUR-YEAR BACHELOR'S DEGREE (OR EQUIV.)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
UWA	23	22	32	46	51	40	29	10	13	16
Monash	0	0	0	0	11	10	12	8	6	10
Fed Uni	0	0	0	0	4	9	18	6	3	2
UoW	23	34	49	24	35	31	23	30	14	20
Curtin	69	61	71	52	56	53	36	26	22	20
UQ	50	44	46	73	65	53	40	22	14	18
UNSW	50	54	52	50	78	68	86	58	32	15
Adelaide	34	39	47	42	33	33	26	19	7	3
Total	249	254	297	287	333	297	270	179	111	104

Data source: Peter Knights, "Australian Graduate Mining Engineering Statistics 2009-2020," SharePoint, (March 2021).

Although there were an estimated 104 graduate mining engineers in 2020, informed estimates suggest that many more are required.[20] Knights' research found that approximately 160 graduates are required per year, whereas the Minerals Council of Australia (MCA) estimated that approximately 200 graduates per year are required to meet demand.[21] This would suggest that only around 60% of demand is currently being met.[22] These estimates are difficult to accurately calculate, however, given poor availability of specific data for mining, metallurgy and geotechnical engineers (ref. Section 3 of this report). Most available data is for the discipline as a whole and there is not a coordinated approach to gathering enrolment and completion information from universities, nor is there a coordinated effort to collect workforce planning information from employers.

The decline in graduates is due, in large part, to a major decline in program enrolments. Enrolments peaked in 2012 with 267 first year students enrolled across the Mining Education Australia (MEA) program alone.[23]

This has since been on a downward trend, as have completions post-2016, when the students that enrolled in 2012 would have graduated.[24] It is likely that many Australian mining education programs are not currently financially sustainable at current low enrolment rates, which poses a significant risk to ongoing graduate supply.[25]

A strong theme from interviews was the concern that mining courses could close in the short to medium term due to lack of critical mass. Where 30-40 students constitute the critical mass required for financial viability in a course, it is possible that none of the existing mining programs in Australian universities are financially sustainable at 2020 enrolment rates (see Figure 2).

8 "Metallurgy," AusIMM, accessed on September 13, 2021, https://www.ausimm.com/career-hub/mining-career-pathways/metallurgy/

9 Gavin Yeates, "Educational Pathways for a Future Mining Industry: At the Brink Again!," Minerals Council of Australia (August 2017): 13.

10 How to Become a Metallurgist," The Good Universities Guide, accessed on September 21, 2021, https://www.gooduniversitiesguide.com.au/careers-guide/metallurgist

11 Geotechnical Engineering," AusIMM, accessed on September 13, 2021, https://www.ausimm.com/career-hub/mining-career-pathways/geotechnical-engineering/

12 T. G. Powell, "Australian Geoscience Tertiary Education Profile 2012," Australian Geoscience Council Report, (September 2013): 40.

13 Interview participant, "Interview on the Mining Industry" Interview by Tim Rawlings.

14 "Mining," National Skills Commission, accessed on September 13, 2021, https://www.nationalskillscommission.gov.au/mining

15 AMMA Australian Resources & Energy Group, "Resources and Energy Workforce Forecast 2021-2026," AMMA, no.2 (January 2021): 3.

16 AMMA, "Workforce Forecast," 3.

17 Knights, "Graduate Statistics 2009-2020," 2.

18 Knights, "Graduate Statistics 2009-2020," 2.

19 Knights, "Graduate Statistics 2009-2020," 1.

20 Knights, "Graduate Statistics 2009-2020," 1.

21 Knights, "Graduate Statistics 2009-2020," 1.

22 Knights, "Graduate Statistics 2009-2020," 2.

23 MTEC, "Key Performance Measures," 9.

24 MTEC, "Key Performance Measures," 3.

25 Knights, "Graduate Statistics 2009-2020," 2-3.

If this trend continues, providers may choose to discontinue programs. If the decision is taken to discontinue a program, it would then be extremely difficult and costly to re-establish. This could further embed a longer-term supply shortage. Having a thriving marketplace of mining courses is important for ongoing viability.

For metallurgy specifically, there is a similarly declining trend in enrolments in recent years. Fortunately, this downward trend is not as drastic as it is for programs targeted at developing graduate mining engineers.

Based on the limited information on graduate destinations available, in 2017 the proportion of metallurgy graduates estimated to have taken up a position in the industry was approximately 50% – an increase on the 40% recorded in 2016.[26] The number of metallurgy graduates being produced and taking jobs in the industry is expected to reduce marginally but remain mostly stable in the future.[27]

Another pressing challenge for the resources sector is workforce diversity. Employers are aware of rates of workforce diversity and most are taking meaningful steps towards improvement. Notable examples include the creation of the 'Global Inclusion and Diversity Council', and the LGBT+ inclusion group 'Jasper' at BHP. Rio Tinto are also a founding member of the Champions of Change Coalition to elevate gender equality, whilst also investing $50 million into increasing indigenous participation and leadership.

Notwithstanding these industry initiatives, indicators are showing work needs to be done. Only 17% of students in the mining degree were female, and 27% in metallurgy.[28] The significant overrepresentation of males in the student cohorts may further reinforce an already disproportionately male workforce. [29]

26 MTEC, "Key Performance Measures," 7.
27 MTEC, "Key Performance Measures," 7.
28 MTEC, "Key Performance Measures," 4-7.
29 MTEC, "Key Performance Measures," 7.

2. An overview of previous research

To inform this report, a review of the existing thought leadership was conducted. The few comprehensive resources available offer detailed point-in-time snapshots of challenges facing the industry. The *'Back From the Brink'* report (BFTB), published by the MCA in 1998, successfully acted as a catalyst for much solution-oriented discussion. A subsequent snapshot was offered in 2017 with the publishing of the 'At the Brink Again' report (ATBA).

ATBA's examination of other thought leadership showed that most of the issues found in the BFTB report were still present 20 years later and were being compounded by new issues that have arisen over time.

The main four themes from the reports can be understood as follows:

University offerings are not well aligned with the needs of employers

The skills that graduates have acquired from their engineering degrees were seen to be lacking by many in industry. Whilst graduates were well educated in technical aspects of the profession (focusing on a strong theoretical understanding), they lacked other key skills, knowledge and characteristics that are essential to job readiness,[30] including: communication and people skills, respect for health and safety knowledge, economic and management knowledge, and humility.[31]

Another significant issue for universities has been the attraction and retention of high-quality academic staff.[32]

Traditionally, academic wages have compared poorly with industry wages. As academic salaries are tied to the university it often meant that graduates were earning as much as senior lecturers.[33] Industry salaries grew quickly given the growing demand for graduates. This has led to academia becoming less attractive, and universities struggling to attract world-class academic staff.[34]

The BFTB report has also found that misalignment has arisen between the goals of universities and the needs of the mining industry, causing prior issues to resurface. Some feel that industry is not sufficiently participative in developing work-ready graduates. The BFTB report found that students were struggling to find vacation placements at mining organisations, largely because employers felt that the benefit of having a student on placement did not offset the additional administration and supervision required.[35] Organisations have also been very reluctant to supply data for university projects.[36] Both of these are vital to the industry's expectation of 'job readiness' and greater shared responsibility ought to be established.[37]

The industry also needs to further encourage continuing professional development (CPD), particularly given the likelihood of significant change in ways of working likely to occur between now and the time at which current graduates reach the peak of their careers (in several decades).[38]

Traditional ways of mining are giving way to new models driven by technology, and organisations are adapting to agile, flexible structures as opposed to hierarchical models based on individual disciplines.[39] Organisations are already looking at broader talent pools for their graduate hiring, including software and civil engineers alongside typical mining and metallurgy engineers to support in adaptation.[40] As noted above, some interviewees noted that hiring from outside of the mining specialty degrees does come with a higher amount of risk, given the lack of specialised technical training. A way to address this risk is to provide and encourage constant CPD to ensure that the workforce is appropriately skilled to meet evolving demands.[41]

30 MCA, "Back From The Brink," 17-18.
31 MCA, "Back From The Brink," 17-18.
32 MCA, "Back From The Brink," 21-22.
33 MCA, "Back From The Brink," 21-22.
34 MCA, "Back From The Brink," 21-22.
35 Yeates, "At The Brink Again," 9.
36 Yeates, "At The Brink Again," 9.
37 MCA, "Back From The Brink," 18, 43.
38 MCA, "Back From The Brink," 42-43.
39 Yeates, "At The Brink Again," 10.
40 Yeates, "At The Brink Again," 10.
41 MCA, "Back From The Brink," 42-43.

Encouraging collaboration in the university sector

The way in which universities are incentivised has also caused challenges. The way that public funding has been awarded incentivises universities to exhibit highly competitive behaviour, seeking to attract the best students, deliver the most research and cultivate a differentiated reputation.[42]

This competition led to an unwillingness to share information and resources. The lack of cooperation has been an issue for many years, however since the BFTB report was released, changes were made to address it.[43]

In 1999, The Minerals Education Council (MEC) set up the Minerals Tertiary Education Council, and began working with universities and the federal government to design a network of selected university departments dedicated to delivering world-class education after the report's release.[44] This led to the creation of the MEA program which consisted of the University of Queensland, the University of New South Wales, Curtin University, and later Adelaide University.[45] These universities developed a common curriculum taking on key skills recommendations including soft skills, and introduced a generalised first year (focusing on cross-sectoral engineering skills).[46]

The introduction of this program meant that students did not have to choose mining straight out of high school, and instead allowed the industry to target their recruitment efforts on them in early university to encourage them to specialise in mining as part of their degree.[47] It was recommended that the recruitment and engagement efforts should focus specifically on females or other underrepresented populations to rebalance the workforce. Unfortunately, recent examinations have shown that the industry is still disproportionately male and lacking diversity.[48]

The creation of the common curriculum was seen as improving the quality and quantity of graduates, although it has given rise to another issue. By focusing on general engineering in the first year, the specialist mining skills and knowledge then had to be condensed into fewer years.[49] Furthermore, differing academic year structures (semesters compared to trimesters) made it difficult for the MEA program to remain nationally consistent and aligned across providers when it came to clustering material into subjects and exams.[50]

The ATBA report recommended that the MEA program be discontinued, arguing that it runs counter to current university business models (built on competition), and that it does not properly address the needs of regions.[51]

Now, each university has slightly differing areas of focus to some degree based on the geographic profile and resource distribution.[52] It has been argued that this has a positive effect, notwithstanding the fact that it undermines efforts to achieve national consistency in university curricula.[53] Some suggest that the ideal model for universities is to find a middle ground between core mining generalist units and specialised electives.[54]

Opportunities exist in micro-credentialing and alternative pathways

Some believe that micro-credentialing would relieve some of the pressure from the universities by allowing for selective specialisation that is not possible in an already-full general curriculum.[55] Micro-credentials usually take the form of short courses, relevant for those who have and have not completed prior study and provide a unique recognition of educational attainment.[56]

Another popular alternative is an associate degree approach. Using this approach, students can begin their careers and benefit from the hands-on approach without an overemphasis on catering to specific assessment criteria.[57] There are reservations that this model is not scalable to the extent required to support the volume of enrolments needed to service growing demand for graduates.[58]

Greater government participation is needed

Governments may be able to play a role in helping the industry by collaborating with universities to support their targeting initiatives and increase interest in mining as a career pathway. Emerging issues are the growing anti-mining perception (particularly of millennials) and the removal of geology and geography from senior secondary (Year 11 and 12) curricula.[59]

The federal and state/territory governments could be key to helping to refresh the industry's image and spread awareness about its importance in the economy, and how the industry is transforming to be aligned with evolving socio-cultural and environmental stances.

In summary, all stakeholders – the education sector, industry, and government – need to be aligned and together carrying out a plan of action to solidify the future mining workforce by tackling the problems that the industry currently faces.

42 Yeates, “At The Brink Again,” 7.
43 Yeates, “At The Brink Again,” 4.
44 Yeates, “At The Brink Again,” 3-4.
45 Yeates, “At The Brink Again,” 4.
46 Yeates, “At The Brink Again,” 4.
47 Yeates, “At The Brink Again,” 7.
48 Yeates, “At The Brink Again,” ii.; MTEC, “Key Performance Measures,” 4-7.

49 Yeates, “At The Brink Again,” i.
50 Yeates, “At The Brink Again,” 7.
51 Yeates, “At The Brink Again,” 8.
52 Yeates, “At The Brink Again,” 8.
53 Yeates, “At The Brink Again,” 8.
54 Yeates, “At The Brink Again,” 8.
55 Yeates, “At The Brink Again,” 7.
56 Yeates, “At The Brink Again,” 7.

57 Yeates, “At The Brink Again,” 11-12.
58 Yeates, “At The Brink Again,” 11-12.
59 Knights, “Graduate Statistics 2009-2020,” 3.

3. Supply and demand forecast

Forecasts developed as part of this report show that a significant (and increasing) disparity between demand for mining engineers and supply of graduates is likely to 2040 and beyond. This is the result of 20 years of projected demand growth coupled with a flat supply of skilled workers via undergraduate university programs.

All three occupations are expected to be in high demand. The National Skills Commission (NSC) projects either 'strong' or 'very strong' growth in each. The NSC projects 13.9% growth for mining engineering over the next five years. Projections are even more promising for metallurgical engineering (21.5% growth to 2025) and geotechnical engineering (15.2% growth to 2025).

Enrolments in undergraduate university programs (a key pipeline of skilled workers for the industry) are declining, based on the limited available data. Supply-side data applies only to mining engineers and the volume of supply of metallurgical and geotechnical engineering graduates is unclear. The projections in this report do not consider other supply sources such as vocational training pathways or skilled migration.

The demand forecasts developed as part of this report consider four potential scenarios for the Australian mining sector through to 2040, and therefore demand for mining engineers, metallurgical engineers and geotechnical engineers. The scenarios reflect upside and downside scenarios for both coal (thermal and metallurgical) and minerals demand, such as iron ore, copper, gold and nickel.

Important note on the scenarios

Following the release of the first version of this report, which was presented to the Resources Education Collaboration Summit (RECS), participants provided feedback on the likelihood of the scenarios presented below.

For context, RECS was held in the week preceding the 2021 United Nations Global Climate Change Summit in Glasgow. Discussions on climate policy, including the future of certain commodities, were dominating international and domestic headlines at this time.

Consequently, it was noted that Scenarios 1 and 2, which had an upside for coal, are highly unlikely. The Working Group clearly noted that the likely scenario was that there would be a decrease in demand for coal. With respect to metals, the Working Group noted that given the prevalence of minerals in new technologies, particularly those required to achieve climate policy targets, demand would likely hold or increase.

Notwithstanding this, the four-scenario approach is designed to allow the reader the scope to explore multiple situations and their impact on the engineering workforce.

It should also be noted that if coal declines, according to the scenarios, the demand for mining engineers declines. This is a clear consequence of the large prevalence of coal mining in Australia currently. This does not mean that the issues outlined in this paper are resolved. As discussed in the supply section later, the severe drop off in graduates means that a slight decline in demand as a result of coal's regression would only marginally ameliorate these issues.

Scenario 1: Upside scenarios for both coal and minerals demand

Coal demand exceeds expectations through to 2040. Energy policy uncertainty and strong export demand continues to fuel coal demand through to 2030. Coal demand tempers from 2030, though not as sharply as currently anticipated due to technological advances in carbon capture and storage and decarbonisation of the mining value chain through vehicle electrification and automation.

Minerals demand remains strong through to 2040. Iron ore demand is buoyed by economic growth and urbanisation among developing nations, offsetting stabilising iron ore demand from China.

Australia seizes a significant opportunity in critical minerals, such as copper, lithium and rare earth metals, fuelling global demand for consumer electronics, electric vehicles and battery storage technology.

Scenario 2: Upside scenario for coal demand, downside for minerals

Coal demand exceeds expectations through to 2040, as described in Scenario 1, however minerals demand is softer than expected. Chinese demand for Australian iron ore tapers amid heightened geopolitical tensions and reduced construction activity. Global iron ore supply increases as Brazilian exports come back online and new iron ore deposits are developed. Increased supply intensifies competition for the commodity, harming prices and Australian export volumes.

Australia is slower to seize critical minerals opportunity and faces robust global competition. Furthermore, the uptick in critical minerals demand does little to offset reduced iron ore exports, further diminishing economic activity in the minerals metalliferous mining sector.

Scenario 3: Upside scenario for minerals demand, downside for coal

Minerals demand remains strong through to 2040, as described in Scenario 1, however is offset by a sharp decline in coal demand. Coal exports plunge amid accelerated geopolitical action on emissions, cheaper renewables and technological advances in battery storage technology. Thermal coal exports decline significantly through to 2030 as historically low prices are no longer able to support operating margin across mine and power plants. Metallurgical coal demand persists modestly through to 2030, before declining due to technological advances in streel production and other industrial applications reliant on the commodity.

Scenario 4: Downside scenarios for both coal and minerals demand

Both coal and minerals demand fail to meet expectations, as described in Scenarios 2 and 3. This sees Australia's mining workforce downsize significantly by 2040, with ongoing minerals demand unable to offset the drop off in coal demand.

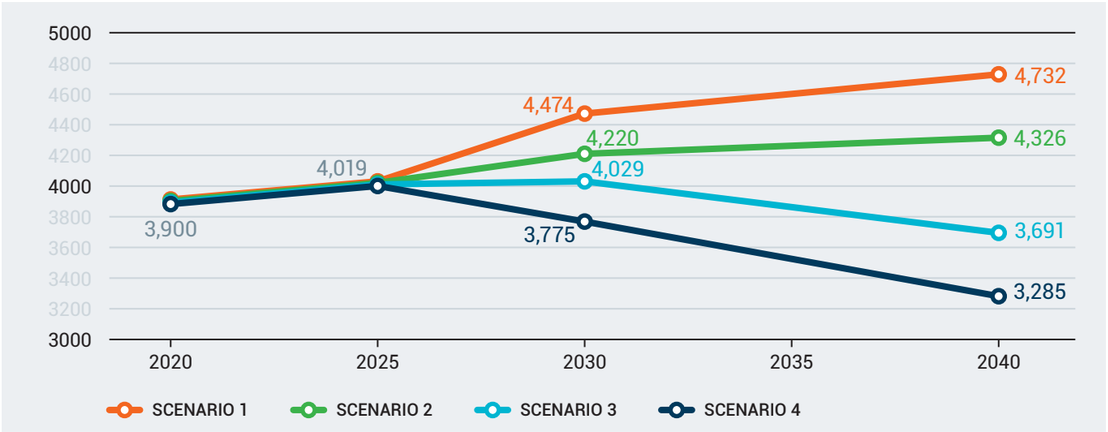
FIGURE 3: COMMODITY DEMAND FORECAST

COMMODITY DEMAND FORECAST	CURRENT FTE (2020)	5 YEAR % (2025)	10 YEAR % (2030)	20 YEAR % (2040)	5 YEAR FTE (2025)	10 YEAR FTE (2030)	20 YEAR FTE (2040)	GROWTH (2020-40)
Coal (+)	60,000	1.5%	5.0%	2.5%	60,900	63,945	65,544	9%
Coal (-)	60,000	1.5%	-25.0%	-50.0%	60,900	45,675	22,838	-62%
Metals (+)	100,000	4.0%	15.0%	7.5%	104,000	119,600	128,570	29%
Metals (-)	100,000	4.0%	5.0%	2.5%	104,000	109,200	111,930	12%

FIGURE 4: MINING WORKFORCE SCENARIOS

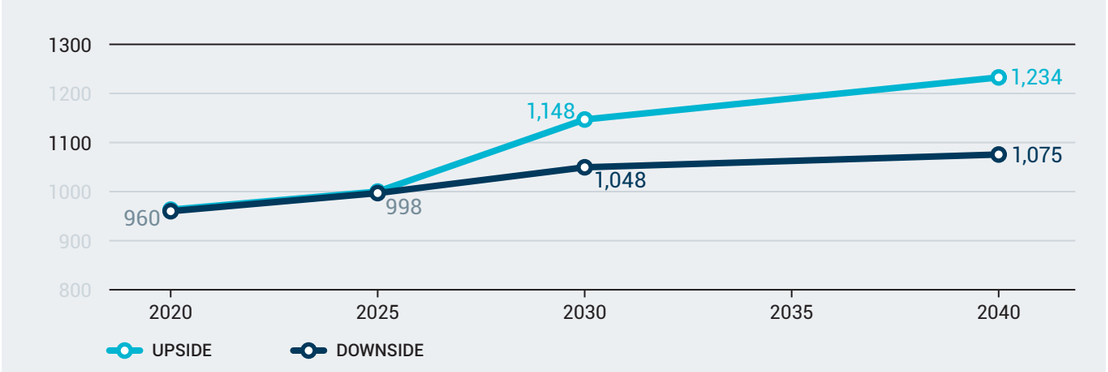
#	MINING WORKFORCE SCENARIOS	CURRENT FTE (2020)	5 YEAR FTE (2025)	10 YEAR FTE (2030)	20 YEAR FTE (2040)	CAGR (2020-25)	CAGR (2025-30)	CAGR (2030-35)	CAGR (2035-40)	GROWTH (2020-40)
1	Coal (+) Metals (+)	160,000	164,900	183,545	194,114	0.6%	2.2%	0.6%	1.0%	21.3%
2	Coal (+) Metals (-)	160,000	164,900	173,145	177,474	0.6%	1.0%	0.2%	0.5%	10.9%
3	Coal (-) Metals (+)	160,000	164,900	165,275	151,408	0.6%	0.0%	-0.9%	-0.3%	-5.4%
4	Coal (-) Metals (-)	160,000	164,900	154,875	134,768	0.6%	-1.2%	-1.4%	-0.9%	-15.8%

FIGURE 5: MINING ENGINEERS (EXCLUDING PETROLEUM) FORECAST TO 2040



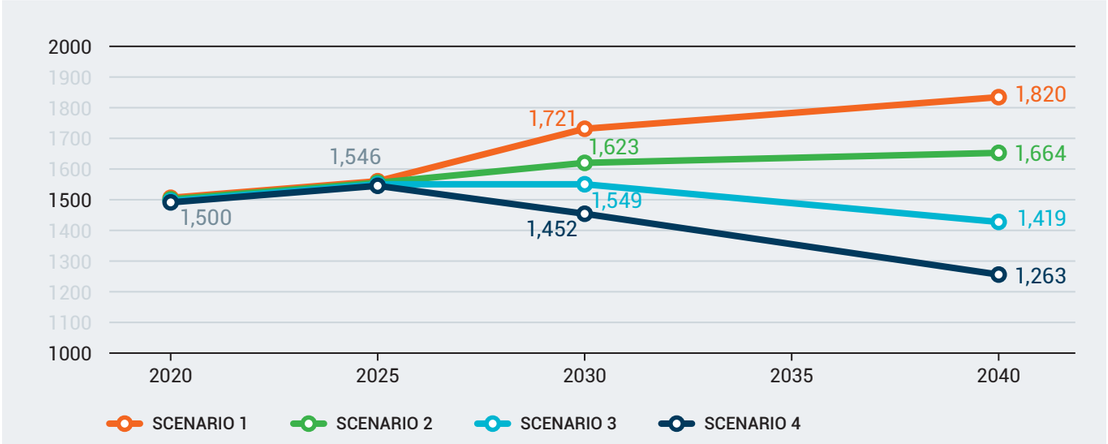
#	MINING ENGINEER SCENARIOS	2020	2025	2030	2040	CAGR (20 YEARS)	GROWTH (2020-40)
1	Coal (+) Metals (+)	3,900	4,019	4,474	4,732	1.0%	21%
2	Coal (+) Metals (-)	3,900	4,019	4,220	4,326	0.5%	11%
3	Coal (-) Metals (+)	3,900	4,019	4,029	3,691	-0.3%	-5%
4	Coal (-) Metals (-)	3,900	4,019	3,775	3,285	-0.9%	-16%

FIGURE 6: METALLURGICAL ENGINEERS FORECAST TO 2040



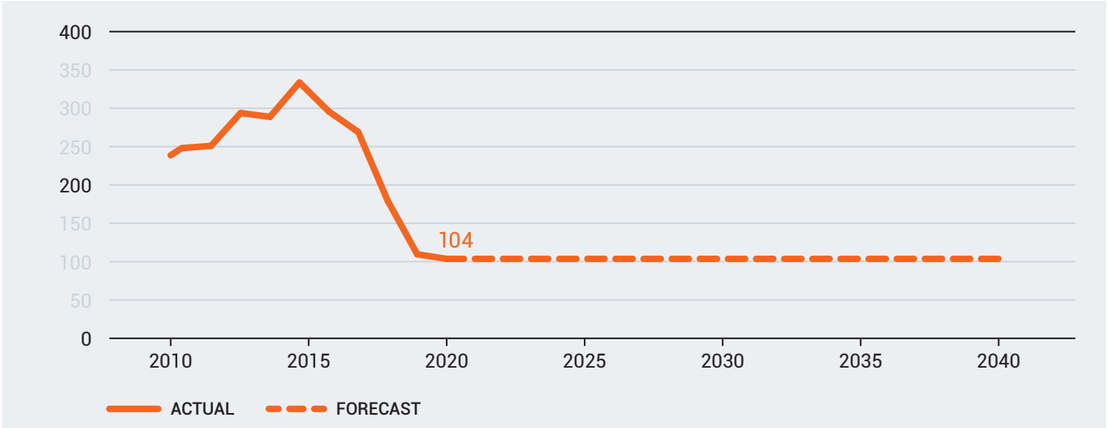
#	METALLURGICAL ENGINEER SCENARIOS	2020	2025	2030	2040	CAGR (20 YEARS)	GROWTH (2020-40)
1	Metals (+)	960	998	1,148	1,234	1.3%	29%
2	Metals (-)	960	998	1,048	1,075	0.6%	12%

FIGURE 7: GEOTECHNICAL ENGINEERS FORECAST TO 2040



#	GEOTECHNICAL ENGINEER SCENARIOS	2020	2025	2030	2040	CAGR (20 YEARS)	GROWTH (2020-40)
1	Coal (+) Metals (+)	1,500	1,546	1,721	1,820	1.0%	21%
2	Coal (+) Metals (-)	1,500	1,546	1,623	1,664	0.5%	11%
3	Coal (-) Metals (+)	1,500	1,546	1,549	1,419	-0.3%	-5%
4	Coal (-) Metals (-)	1,500	1,546	1,452	1,263	-0.9%	-16%

FIGURE 8: FORECAST SUPPLY OF MINING ENGINEERING GRADUATES TO 2040



Forecasting methodology

Demand

A forecasting model was developed to estimate the impact of the four scenarios on each of the three occupations over 5-, 10- and 20-year forecast horizons. The model uses publicly available data from the Australian Government and NSC (where appropriate) as well as reasonable estimates based on industry analysis, insights from subject matter experts and historical trends.

The forecast model uses a two-step approach. The first step was to establish a baseline for the current mining workforce in Australia from which the scenario forecasts could be projected. Notably, the baseline only includes two ANZSIC codes within the 'Mining' industry classification: '060 Coal mining' and '080 Metal ore mining'. Other ANZSIC codes within the 'Mining' industry classification were excluded as they were determined to be less relevant or not applicable to the three occupations, such as '070 Oil and gas extraction', '091 Construction material mining' and '099 Other non-metallic mineral mining and quarrying'.

Once the baseline was established, using Labour Market employment levels for '060 Coal mining' and '080 Metal ore mining' at November 2020, upside and downside employment forecasts were estimated for each commodity over 5-, 10- and 20-year horizons. For the 5-year horizons, projections were inferred from the September 2021 Resources and Energy Quarterly, which contains the Office of the Chief Economist's forecasts for the value, volume and price of Australia's major resources and energy commodity exports. Estimates for the 10- and 20-year horizons, were based on industry analysis, insights from subject matter experts and historical trends. Once upside and downside forecasts were developed for each commodity, they were grouped to form the four scenarios.

The second step was the apply the scenario forecasts across each of the three occupations. All four scenarios were applied across mining engineers and geotechnical engineers, however only the upside and downside minerals demand forecasts were applied for metallurgical engineers, given that the occupation does is not applicable to the coal industry.

Limitations

The forecast model assumes that mining workforce growth rate projections will be the same as those of the three occupations. This is not necessarily the case as there are occupation-specific factors that will shape their individual growth rates. For example, increased uptake of autonomous machinery is expected to put downward pressure on demand for mobile plant operators, such as haul truck drivers. However, this driver may have the inverse effect on the demand for mining engineers, as their skills will be increasing required to redesign the mining value chain for autonomous operations.

Occupation analysis

Mining engineer

According to JobOutlook, there are currently 3,900 Mining Engineers (excluding Petroleum) (ANZSCO ID 233611). As indicated in Figure 5, under Scenario 1 mining engineer employment levels may increase by 21% to 4,732 by 2040. Under Scenario 4, employment levels may decrease by 16% to 3,285 by 2040.

While Labour Market 5-year employment projections are publicly available for Mining Engineers (ANZSCO ID 2336) – for which there are currently 11,000 workers – they are not available for Mining Engineers (excluding Petroleum) (ANZSCO ID 233611). Given that the Labour Market employment projections reflect underlying oil and gas demand, they were not adopted for the forecast model.

Metallurgical engineer

According to JobOutlook, there are currently 960 Metallurgists (ANZSCO ID 234912). As indicated in Figure 6, under the minerals demand upside scenario metallurgist employment levels may increase by 29% to 1,234 by 2040. Under the downside scenario, employment levels may increase by 12% to 1,075 by 2040. Given that demand for this occupation should be exogenous to coal demand, it is expected to exhibit growth under both scenarios.

Geotechnical engineer

According to JobOutlook, there are currently 1,500 Geotechnical Engineers (ANZSCO ID 233212). As indicated in Figure 7, under Scenario 1 employment levels may increase by 21% to 1,820 by 2040. Under the downside scenario, employment levels may decrease by 16% to 1,263 by 2040.

It should be noted that ANZSCO classifies geotechnical engineers as a subcategory under Civil Engineering Professionals (ANZSCO ID 233212). Given this, it is likely that there are currently fewer than 1,500 working in the coal and metalliferous mining sectors as some would work in civil construction and quarrying. As such, all scenarios likely overstate the employment levels of geotechnical engineers working in the mining sector.

Supply

A full supply model should account for workforce entrants (or re-entrants) through domestic education and training, skilled migration, upskilling from within the industry, and workforce exits or retirements. This report only examines supply through the lens of university graduations, with data only available for mining engineering programs.

The growing shortfall must be addressed either by increasing graduate supply, or through other means such as those listed above.

The graduate supply forecast is based on graduation figures (2010-2020) from eight Australian universities, namely the University of Western Australia, Monash University, Federation University Australia, University of Wollongong, Curtin University, University of Queensland, University of New South Wales and University of Adelaide.

The assumption was made that university graduations remain flat between 2020 and 2040. The inflating impact of the mining boom has ended (ref. Figure 8) and incentive factors, such as graduate salary and progression, do not seem to be materially impacting graduation figures. There are no other external factors that would otherwise promote an increase in enrolments. The forecast nil growth represents a constructive decline, given that population will grow over the same period.

Limitations – Highly limited availability of relevant supply-side data

The supply estimate was made (only for the mining engineer job role) based on undergraduate university graduation figures. As discussed above, this is not a true representation of supply.

The enrolment data was submitted voluntarily and may contain inaccuracies. No data was available that enables analysis that is specific to the metallurgical and geotechnical engineer job roles.

The cyclical nature of mining activity further complicates efforts to project supply. Increases in graduate employment generally lag behind increases in commodity prices and mining activity which may impact enrolments and graduations.

Demand

Factors that influence demand

Demand for mined commodities is the greatest driver of mining activity which, in turn, drives employment growth. Exploration and mining activity are influenced by commodity prices, which increase or decrease in response to demand for mined materials and are hard to predict. Higher commodity prices incentivise mining activity (as mining operations have greater opportunity for profitability), whereas low commodity prices have the opposite effect. During times of international industrialisation there has been significant demand for mining products, and if emerging economies continue developing, there is likely always to be reliable demand.[60]

An increase in mining activity is the primary driver of demand for skilled workers in mining, metallurgical and geotechnical engineer job roles, as the more jobs are created, the more workers are needed to fulfil them.

Factors specific to metallurgical and geotechnical engineering

Demand for metallurgical engineers is likely to remain high. This is primarily driven by the global megatrend towards Net Zero which will increase the demand for products and equipment that rely heavily on minerals and metals, as well as ongoing demand.

The demand for geotechnical engineers is not just driven by the mining industry. Australia's growing cities with their strong demand for major projects mean that civil infrastructure sector will need geotechnical engineers, particularly for tunnelling. Consequently, supply/demand concerns for these engineers may be exacerbated.

60 'Drivers of Growth,' Queensland Resources Council, accessed on September 13, 2021, https://www.qrc.org.au/contributiontoqueensland/drivers-of-growth/

A snapshot of current demand

To better understand circumstances surrounding supply and demand, AusIMM surveyed a collection of resource sector employers. 23 responses were received, comprising a mix of small and large organisations operating across all states and territories.

In relation to mining engineers, most respondents believe that demand will increase (between 'slightly' and 'largely') over the coming 5-, 10- and 20-year horizons. Respondents believe that the strongest increase will take place in the next 5 years, while 20% of respondents believe demand will remain the same. Over the 10- and 20-year forecast horizons, 5% and 15% of respondents, respectively, predict that there will be a decrease in demand, and more believing demand may remain the same.

The trend is similar but not as strong for metallurgical engineers. Over the 5-year forecast horizon, the majority (65%) of respondents believe that demand will increase. Despite this, most respondents believe that demand will remain about the same over the 10 year (68%) and 20 year (58%) forecast horizons. Two respondents believe that demand will decrease in 20 years.

For geotechnical engineers, the strong majority of respondents (85%) believe an increase in demand will occur in the coming 5 years. A slightly lesser majority believe that there will be an increase in demand over the 10-year (57%) and 20-year (53%) forecast horizons. 32% of respondents believe that demand will remain the same over the next 10 and 20 years, while 11% believe that demand will decline over these time periods.

These figures broadly support the macroeconomic modelling from the NSC. Like the NSC data, most companies project their demand up to five years. However, companies have multiple considerations in determining their demand that are not captured in broader data sets. As one respondent said, "determining how many engineers we need has one foot in the people camp and one foot in the technical."

Despite the cyclical nature of the industry, respondents generally thought graduate demand has been relatively stable.

Interestingly, while respondents felt there was a co-ordinated approach to graduate recruitment, lateral hiring and broader "strategic workforce planning" were not as strong. Another respondent suggested that more could be done to reintegrate engineers who have left the industry for family reasons. This would have the added advantage of supporting female employment rates.

FIGURE 9: ANTICIPATED DEMAND FOR JOB ROLES AMONG MINING EMPLOYERS

	LARGE DECREASE	SLIGHT DECREASE	REMAIN THE SAME	SLIGHT INCREASE	LARGE INCREASE
MINING ENGINEERS					
5 years	0%	0%	20%	45%	35%
10 years	0%	5%	37%	42%	16%
20 years	6%	10%	39%	39%	6%
METALLURGICAL ENGINEERS					
5 years	0%	0%	35%	50%	15%
10 years	0%	0%	68%	16%	16%
20 years	5%	5%	58%	21%	11%
GEOTECHNICAL ENGINEERS					
5 years	0%	0%	15%	50%	35%
10 years	0%	10%	32%	32%	26%
20 years	5%	1%	32%	26%	26%

Data source: Mining industry employer survey conducted by AusIMM Limited

Another divergence between overall data and company perception may be the "movement factor". Resourcing of engineers is "always on code amber" and, at the moment, interview respondents suggested there is 10-20% unmet demand. As a result, it is a good market to move organisations if you are an engineer and this movement leads to a concern about the future supply of engineers. Organisational restructures, even in the strong part of the cycle, are also a contributing factor.

Understanding what skills are in demand

To accurately forecast demand for skilled workers it is important to understand what skills people will need, not just how many people are needed.

In mining, as in many other industries, the primary cause of skills evolution is technology. This evolution is precisely that, the incremental erosion of certain tasks because of technology, for them to be replaced by (hopefully) higher value tasks. As one respondent put it, "the aggregate volume of work will increase" but this will result in a different configuration of tasks. Some work will be distributed to field technicians while some will be the domain of data scientists.

Automation is being introduced to key aspects of mining operations. These technological advancements offer efficiencies and increase safety by replacing humans in dangerous aspects of mining operations. Demand, therefore, is for individuals with non-static skill sets.
The ability to learn is a skill that has never been more important to employers. Some have recently advocated for expanding the skill set taught to students considering the ever-changing technological environment.

There is also demand for emerging roles that have not previously existed or have been significantly augmented. One employer expressed the view that "graduate demand has been relatively stable over the years, but there is a growing demand for other roles that may not have been required a few years ago, such as software engineers."

This lack of skills alignment results in knowledge gaps, and an increased organisational risk profile which has the potential to translate into a production issue.[61] The role of a miner is changing and the breadth of work that they will have to do is increasing.[62]

Furthermore, some employers find that graduates are not sufficiently digitally literate, not having been taught enough about the types of robotics or automation adopted by the industry.

Engineers will also be required to think about the "bigger picture" that mining operates in, particularly with respect to ESG principles. Some also expressed the desire for engineers to be more literate with risk and comfortable with ambiguity.[63]

The employer survey corroborates these views. Asked what skills or attributes were needed to improve the quality of graduates, 44% said soft skills and essential non-mining knowledge, like an understanding of business, were needed. 50% said more practical experience was necessary, so graduates have exposure to the kinds of tasks they need to know how to do, whether that be experience underground or becoming familiar with technology.[64]

61 Interview participant, "Interview on the Mining Industry" Interview by Tim Rawlings.
62 Interview participant, "Interview on the Mining Industry" Interview by Tim Rawlings.
63 Interview participant, "Interview on the Mining Industry" Interview by Tim Rawlings.
64 AusIMM Limited employer survey, September 2021.

Data skills are particularly essential. As one interviewee put it, "engineers used to struggle to get data, now there is too much data for their skills to handle." Graduates need the skills to be able to navigate a data-rich environment.[65]

Graduates also need to be able to correctly estimate their own abilities. The high demand (and therefore competition) for graduates has led to high entry salaries, which may have some overestimate their abilities, resulting in workplace errors and workforce planning issues.[66]

These emerging transferable skill requirements are in addition to, and do not replace, fundamental technical skills and knowledge associated with mining job roles.[67] The technical skills are essential to the individual understanding the industry domain, and the transferable skills support them in job-readiness and effectiveness in their role.

Supply

As established above, graduate supply numbers are trending downward. The employer survey indicated that 87% found it 'difficult' or 'very difficult' to find suitably qualified engineers to recruit in the last 24 months. Only 4% found it 'very easy' to find suitable candidates.

The survey also found that 48% of respondents were 'very concerned' about sourcing suitably qualified engineers in the next 24 months. 39% were 'concerned' and the remaining 13% were neutral. No organisation responded positively (i.e. optimistic rather than concerned) to this question.[68]

Factors that influence supply

The number of available skilled workers is dictated by: (a) the number of students training or retraining in Australia, (b) the number of people remaining in or re-entering the workforce and (c) volume of skilled migration, less the number of individuals exiting the workforce (e.g. as a result of retirement). This report focuses primarily on the availability of skilled workers through onshore education and training pathways.

65 Interview participant, "Interview on the Mining Industry" Interview by Tim Rawlings.
66 Interview participant, "Interview on the Mining Industry" Interview by Tim Rawlings.
67 Interview participant, "Interview on the Mining Industry" Interview by Tim Rawlings.
68 AusIMM Limited employer survey, September 2021.

The number of students enrolling and completing relevant university qualifications provides the best indication of short-term supply. These figures are influenced by a range of factors:

Decline in enrolments

University entrants are choosing to study mining-related qualifications in decreasing numbers. This decline in enrolment has remained consistent since 2015 and has resulted in a declining number of graduates.[69]

This is the fundamental pain point to the supply and demand equation in this report.

Employers and universities are reporting difficulty in attracting enthusiastic and motivated people into mining education pathways, and that this has been significantly compounded by disruption caused by the COVID-19 pandemic.[70]

Though current border closures have temporarily halted the arrival of international students, many believe that this is likely to have longer lasting effects. Some in industry believe that face-to-face learning will either not exist or will be significantly reduced.[71] The impact of this is that competing courses or disciplines might become more attractive and exacerbate the current difficulties.

There is very little information on the true motivating factors for student choices. There were some strong themes in interviews about the reasons for the decline including: perception of the industry (expanded below), removal of subjects from school curriculum and the prospect of moving to regional areas. These were not, however, universally held.

One observation that was consistent across interviewees was the acknowledgement that graduate outcomes are not acting as a strong pull factor. Some respondents suggested that the "payoff" was too far away. This issue is not confined to the mining industry with broader system decisions making the potentially false assumption that graduate outcomes drive course choice.

Students make their choices based on "influencers" that stretch back to early high school. Parents, friends, and teachers are very influential. There have been attempts to influence the influencers with mixed results, but respondents felt this was a necessary part of changing perception.

69 Knights, "Graduate Statistics 2009-2020," 2.
70 Interview participant, "Interview on the Mining Industry" Interview by Tim Rawlings.
71 Interview participant, "Interview on the Mining Industry" Interview by Tim Rawlings.

Public perception of the industry

A common concern is that graduate supply is being heavily impacted by an unfavourable perception of the mining industry within younger generations.[72] The current social climate in Australia, as well as in many other countries, is one of concern for the environment and aversion to unsustainable practices.

A similar concern is that the perception of the entire industry is conflated with specific concerns about coal. This perception, according to interviewees, neglects the contribution other commodities have on environmental sustainability through their presence in Net Zero technologies and equipment.

Media coverage is a significant contributor to the above perceptions. Lithium, for example, is an essential element in batteries required for electric cars.[73] Mining is essential for the sustainable resources future, however a strong sentiment in respondents was that this fact is not well known or communicated.

Millennials tend to place great weight on moral considerations when making consumer and career decisions. The impact of this is that the attractions of a career in the mining industry (high starting wage and career progression prospects) are seemingly not enough to influence the decisions of university entrants.[74] Some interviewees noted that the influencers of school aged children may be a stronger factor in declining numbers than any other.

Further impacting the reputation of the industry are: the perception that the industry is not innovative, the prevalence of FIFO work, concerns relating to workforce diversity (most notably gender diversity), and frequent media reports on rates of sexual harassment.[75]

Job readiness

Supply of suitable graduates is impacted by a disconnect between employers and universities regarding expectations of job readiness. From the perspective of employers, students should be trained to the requirements of a graduate job role. Graduates ought to be (at least close to being) ready for work on completion.

72 Yeates, "At The Brink Again," 6.
73 Interview participant, "Interview on the Mining Industry" Interview by Tim Rawlings.
74 Yeates, "At The Brink Again," 6.
75 Interview participant, "Interview on the Mining Industry" Interview by Tim Rawlings.

Some universities take a different view. The general view is that the objective of university should be to develop a good understanding of fundamental principles, and broad skills on how to be professional. This view believes there will always be a gap when the student leaves university and that this is the employer's responsibility to fill. The last point is seen as important – many in the university sector lament the seeming reluctance of employers to participate in helping students achieve readiness for a job in industry.[76]

Industry representatives believe that employers 'cannot continue to educate graduates the way they have been'[77] and that university ought to be more comprehensive. Industry representatives expressed the need for greater time to be spent in the field during the qualification which, in their view, will lead to individuals being able to experience more when they are in the organisation.

Employers are beginning to remedy the perceived disconnect between the last day of university and the first day of employment. In order to strengthen the continuum of learning, programs are being developed by companies including BHP and Rio Tinto to offer students internship opportunities as early as their first year into their degree. This may go some way towards bridging the gap students are experiencing when they transition from study to work.

Graduate expectations

Respondents also noted that the culture of current graduates perceive themselves to "know everything" in a limited time before moving to a metropolitan job. Relatively large salaries and the overall demand for their services means graduates are in a very strong position to be promoted quickly, which sometime happens before the individual is "ready". The result is some "significant workforce planning issues" in trying to have suitable people in the right roles.

76 Interview participant, "Interview on the Mining Industry" Interview by Tim Rawlings.
77 Interview participant, "Interview on the Mining Industry" Interview by Tim Rawlings.

4. Recommendations

Establish an improved and consistent method for data gathering and reporting

To facilitate effective workforce planning, the industry needs access to better and more targeted workforce data, delivered in a timely manner. Such information will help identify areas of priority and support data-driven decision making on initiatives aimed at addressing key workforce challenges. Providing stakeholders (e.g. employers and educators) with a shared view of requirements will also support collaboration.

A substantial barrier to effective forecasting, particularly supply, is that much of the required data is unavailable, unreliable, scattered between multiple sources, or insufficiently precise. For example, whilst some data on university graduations is available (albeit only for mining engineers), data is not available at an industry-level to identify the rate at which individuals are transitioning between job roles or exiting the workforce – both of which are key factors in determining supply.

These challenges would be addressed by a central data repository that is tailored to the needs of the industry, underpinned by current and accurate information reported by employers, educators and other relevant stakeholders.

Encourage collaboration between industry and Higher Education

Educators and employers share significant responsibility for workforce talent pipeline and the mining industry would be well-served by closer collaboration between the two stakeholder groups. Formal mechanisms should be established to encourage and incentivise partnerships, particularly as it relates to graduate pathways.

These communication channels will ensure that there is a shared understanding of the challenges facing the industry and that learners are being equipped with the necessary skills, knowledge, and experience to be job-ready sooner. Collaboration ought to address course curricula and work placement programs for undergraduate students, both of which would address challenges identified in this and previous reports.

The goals of universities and the needs of industry need to be better aligned. Engagement must go further than employers simply telling the universities what they need; the industry needs an effective way to support students throughout university to make the transition into employment easier. There needs to be a higher level of collaboration to ensure that changes can be thoroughly discussed, planned and actioned. The collaborative effort may help to prevent recurring issues, whilst establishing a shared responsibility, and creating a stronger continuum between university and employment.

Conduct targeted public education to foster greater understanding of the resources industry

Addressing the shifting public perception of the resources industry (i.e. that it is environmentally harmful) is key to its future prosperity. This is particularly the case as it relates to increasing the supply of graduates in line with forecast healthy long-term demand.

A misconception, most prevalent among younger generations, is that all mining activity is in opposition to environmental sustainability. Values-alignment is becoming an increasingly critical factor in study and career choices for young people, with traditional incentives like high graduate salaries diminishing in effectiveness. It is therefore vital that this becomes the language that industry uses when communicating with prospective students. Communication must be seen to be authentic (rather than contrived) and speak to the values and sense of purpose that top talent now demands.

This may better educate the public to the benefits of the industry, its contribution to the transition to a green economy, and motivate students to choose mining specialisations in university. Student “influencers” (e.g. parents and teachers) are key to shifting attitudes.

Invest in alternative and sustainable models of education and pathways into the industry

Too great a reliance is currently placed on universities as a source of skilled workforce entrants. The industry should be prepared not only to support new sustainable models for minerals education currently being developed by universities, but also to invest in, pilot, and refine alternative and sustainable training and education pathways at the graduate level. By diversifying the entry pathways, the industry stands to access a broader and more diverse pool of candidates and increase overall graduate supply.

Solutions should be co-designed by educators and employers and address key ‘job-readiness’ skills that are often seen as lacking through traditional pathways. Design should factor in appeal to candidates from different educational, gender and cultural backgrounds. More targeted focus on the skills required to competently perform the job will enable shorter training journeys and get graduates ready and into some jobs sooner however theoretical foundations, which universities are well suited to teaching, will remain crucial to some roles. Clearly, a key element involves enhanced work-integrated learning opportunities. Providing ‘job ready’ graduates needs to be a collaborative process between universities and industry.

A continuous improvement approach – with evaluation and refinement at its core – will enable talent pathways to be targeted and effective, even as the needs of learners and employers evolve over time. Investment (both time and money) is required from all interested parties.