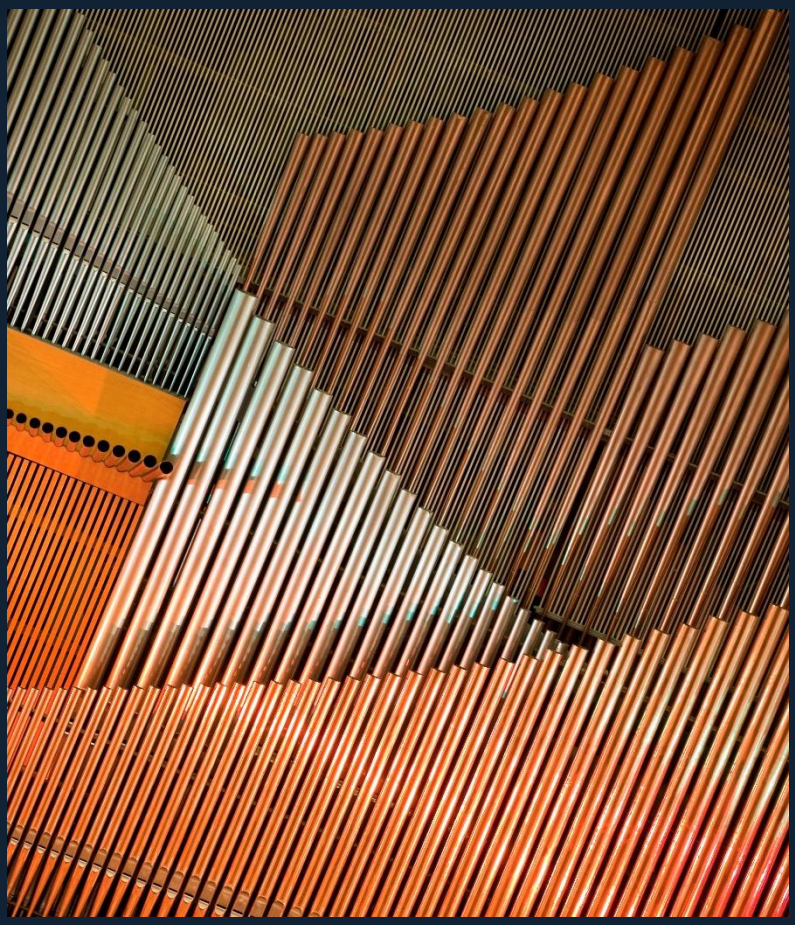
SWANN

White Paper

Education and Industry: Approaches to Addressing the Mining Skills Gap



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I. Introduction

The demand for mining and metals is escalating as population numbers continue to grow and as there are urban and technological developments which require such materials.[1] As John McGagh, former Head of Innovation at Rio Tinto commented in 2011, '*In the next 25 years, demand for metals could meet or exceed what we have used since the beginning of the industrial revolution.*'[2] Further suggesting the significance of this, McGagh noted: '*By way of illustration, China needs to build three cities larger than Sydney or Toronto every year until 2030 to accommodate rural to urban growth, this equates to the largest migration of population from rural to urban living in the history of mankind.*'[3] Along these lines, PwC acknowledged in a 2017 report that '*miners can no longer afford to ignore the role they play in a much larger economic, social and technological ecosystem – an ecosystem that is growing and becoming more complex every day.*'[4]

While the need for mining and natural resources has never been greater, professional and academic interest in the industry has dwindled, leaving mining companies struggling to find the talent required to develop and deliver projects which inevitably require new and increased knowledge of technical areas. This report seeks to consider aspects of this talent gap in relation to education and training by:

- Acknowledging the existing literature on the topic, forming a context for the discussion and indicating where efforts have already been made to remedy the discrepancies in skills and knowledge
- Presenting insights collected from industry leaders on the sorts of skills and experience they believe will be the most important for the future of the industry in the near- and long-term
- Detail on how educational institutions currently approach their curricula and student attraction and retention
- Potential solutions and improvements that can be made

This information was gleaned from desktop research, interviews and surveys conducted by Swann.

[1] D. Barrie Johnson, Nov. 2013, 'Development and application of biotechnologies in the metal mining industry', *Mining and the Environment – Understanding Processes, Assessing Impacts and Developing Remediation* Vol. 20, Issue 11, p. 7768.
[2] Stan Sudol, Jun/Jul 2011, 'It's time to consolidate mining university programs', *Canadian Mining Journal* 132, 5, p. 10.
[3] Sudol, 'It's time to consolidate', p. 10.
[4] PwC, 2017, *We need to talk about the future of mining*, p. 4.

II. Literature Review

The lack of experience, skills and talent in the mining industry is a multi-faceted problem, and one that is of global concern.[5] There are a number of factors contributing to this deficit, which are addressed below.

Globally, the mining industry is up against an aging workforce. Using Canada as an example, the Mining Industry Human Resources Council (MIHRC) has estimated that over half of the Canadian mining workforce is 45 years or older and that more than a third of the workforce will be eligible for retirement over the next several years.[6] Furthermore, it has been estimated that over 60,000 Canadian mining employees will retire by 2020[7] and that by 2023 the Canadian mining industry will require 145,000 new workers, which amounts to over half of the mining work force in the country.[8] Similarly in Chile, it has been projected that the mining industry will require 27,347 workers by 2023 (an estimated 16,000 of which will replace employees who have retired).[9]

Regrettably, interest in joining the mining industry has dwindled in recent years. Some of the most striking figures to this regard have come out of Australia in recent years. In 2018 the Minerals Tertiary Education Council (MTEC) report highlighted a significant decline in enrolment numbers across most higher education disciplines related to mining and metals since 2012. While 2012 and 2013 presented the highest ever number of enrolments in mining engineering, 2018 enrolment was the lowest it has been since 2000. Interest in metallurgy programmes is a similar story, with enrolment also at the lowest level since 2000.[10] Poignantly, in 2018, only six students enrolled in mining engineering at the University of New South Wales, compared to 120 enrolments four years earlier.[11]

There are a number of reasons for the decline in student interest and the dearth of professionals entering the mining labour market. The lack of employment opportunities during the recent downturn (2012 – 2016) and uncertainty in the industry have been one contributing factor. For example, the Australian mining sector lost 55,000 jobs during that period, leading companies to become increasingly unwilling to hire people into permanent roles: 80% of roles advertised during this period were contract roles.[12]

Opportunities in mining have just not been available for recent graduates with the appropriate qualifications and skillsets, forcing them to find work in other industries.[13] This loss in the total number of jobs and the scarcity of permanent jobs in the industry helped to drive people away from the industry while also forcing potential new talent to consider the security of their future in the industry.

Further to these cyclical issues within the industry, there are other factors causing the number of people pursuing mining-related degrees and careers to decline. On one level, a basic lack of awareness of the

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[5] Dale Benton, 28 June 2017, 'Global mining industry suffering a major skills shortage problem, Chamber of Mines finds', *Mining Global*. https://www.miningglobal.com/operations/global-mining-industry-suffering-major-skills-shortage-problem-chamber-mines-finds

[6] Wylie, 'Solving the mining industry's skilled worker shortage', p. 57.

[7] Van Zorbas, Feb/Mar 2011, 'Scarcity of talent threatens profitability', *Canadian Mining Journal*, p. 10.

[8] 12 June 2014, 'Is Canada's mining industry too tough for new talent', *Mining Technology*. https://www.mining-technology.com/features/featureattracting-new-staff-as-canada-delves-deeper-underground-4292728/

[9] Consejo de Competencias Mineras, 'Chilean Large-Scale Mining Workforce 2014 – 2023 Results and Conclusions. http://www.ccm.cl/wp-content/uploads/2016/06/mini_report_english.pdf

[10] Minerals Council of Australia, 'Minerals Tertiary Education Council Key Performance Measures Report 2018'. https://minerals.org.au/sites/default/files/MTEC%20Key%20Performance%20Measures%20Report%202018.pdf

[11] Alex McHugh, 'Tackling the skills shortage in Australia's mining sector', Cormac Consulting. https://cormacconsulting.com.au/2019/05/tackling-the-skills-shortage-in-australias-mining-sector/

[12] Sinead Mangan, 13 June 2018, 'Mining Industry and infrastructure in "war for talent", report finds', ABC News. https://www.abc.net.au/news/rural/2018-06-13/mining-infrastructure-compete-as-demand-workers-grows/9864376

[13] Segran Pillay and Ian G. Goshko, 29 March 2018, 'Miner's Talent Crunch: Attracting and retaining millennials', Accenture. https://www.accenture.com/us-en/blogs/blogs-attracting-retaining-millenials

opportunities available in mining may mean that students never even consider the industry for their careers.[14] Where students are aware of mining as a possible career path, challenging working conditions, long hours and FIFO schedules are all aspects of the mining industry which have been identified as discouraging qualified individuals from continuing or pursuing careers in mining.[15] Furthermore, there is a disconnect between firms, universities and technical schools which result in well-qualified and trained people ending up in jobs that are below their skillsets, degrees and pay grades.[16]

Negative perception of the industry also keeps many from pursuing it professionally.[17] Concerns about environmental[18] and sustainability issues[19] associated with mining detract many from joining the industry which, when compounded with the appeal of industries such as tech that rely on somewhat similar competencies and skills, means that the mining industry does not seem 'cool' to students (speculatively, nor has it for several decades), leading them to pursue academic courses and careers in other areas.[20]

Further to the need to attract people with traditional mining skills, the advancing nature of technology in the mining industry means that people with new and different skills are now also required. Gaps in knowledge are undermining efforts to transform mining technology.[21] In Mexico, for example, there are significant human capital needs at every level of the mining sector's value chain because there are simply not enough qualified people to manage the adoption and assimilation of advancing mining technologies.[22] To fill these new types of roles, the mining industry has to compete with tech companies and other industries for talent. As Graham Kerr, CEO of South32, explained '*those other fields – data scientists, IT, technology people…have a variety of different options outside the mining space and we have to capture the hearts of them.*'[23]

Further to the need for technological expertise, the mining industry now requires a range of soft skills. As noted in a 2009 study carried out by Korn Ferry, there were significantly different expectations for mine managers ten years ago. Previously, the focus was on technical aspects and extracting ore, but now there is an entirely new skill, increasingly rooted in sociology and/or psychology.[24]

These additional skill requirements are perhaps most acutely felt at the executive level, where highly educated and sophisticated individuals with leadership qualities are needed to adequately address industry challenges. Now, in addition to the basics of mining, an executive must be able to assess company, country, and international risk, politics, environmental impact and social commitment. They must also be well-versed in financial areas ,such as strategic planning and banking, public credit and equity markets, among

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[14] 'Is Canada's Mining industry too tough…', 2014.
[15] 'Is Canada's Mining industry too tough…', 2014.
[16] Sollerio et al, 'Human capital for innovation in Mexico's mining industry', June 2017, 2.
[17] Jon Wylie, Feb 2013, 'Solving the mining industry's skilled worker shortage', *Engineering & Mining Journal* 214.2, p. 57.
[18] McHugh, 'Tracking the trends…', p. 22.
[19] 'Mining industry employs creative solutions to solve skills shortage: Workforce development is critical focus for many companies', *Viewpoint: perspectives on modern living*. http://viewpointmining.com/article/mining-industry-employs-creative-solutions-to-solve-skills-shortage
[20] Kristie Batten, 9 January 2018, 'Mining's Quest for Talent', *Mining News* and Dan Hatch, 17 January 2018, 'Experts warn that skills labour shortage looms for mining', *Mining People International*. https://www.miningnews.net/leadership/news/1315243/minings-quest-talent and https://www.miningpeople.com.au/news/experts-warn-skilled-labour-shortage-looms-for-mining
[21] McHugh, 'Tracking the Trends', p. 20.
[22] Jose Luis Sollerio et al, June 2017, 'Human capital for innovation in Mexico's mining industry', 2017 ISPIM Innovation Conference, p. 16.
[23] Batten, 'Mining's Quest for Talent', 2018.
[24] Korn Ferry Institute, 22 October 2009, 'Developing Mining Leadership in the New Millennium', p. 2. https://www.kornferry.com/institute/270-developing-mining-leadership-in-the-new-millennium

other challenges.[25] As one executive noted, '*There has to be more emphasis on the broader business skills...People are coming out of school too technically focused.*' [26]

This combination of factors – the aging workforce, negative perceptions of mining, the draw of other industries, changing expectations of working schedules and environments, fundamental changes in the skills required to work in the industry, and probably many more less-discussed concerns – have come together to create well-known and well-documented employment problems within the industry. Several of these factors can be improved upon, though it would be difficult to fully eradicate the problem. For example, while individuals can choose and/or be persuaded to retire slightly later, they will still retire. Similarly, while it is possible to alter working schedules and conditions to make mining more appealing and suitable to family life, the mines will still be established and found in challenging locations.

Education, however, has the potential to address the shortfall in employees by not only furnishing students with the required skill sets, but also familiarising them with the opportunities available through the mining industry. While mining companies had more involvement with graduate development programmes at universities throughout the 60s, 70s, 80s and 90s, these graduate schemes have since tapered off, resulting in a failure to convert graduates into contributing mining professionals.[27] More recently universities and companies have again started to invest in development programmes, taking a longer-term view of the problem and the solution.

The rest of this report will consider the advancing requirements of the mining industry, suggesting the skills, knowledge and experience that will imminently be required from future industry leaders. It will then look at how universities are working to address these issues, indicating how industry and academia can work together to develop solutions.

[25] 'Developing Mining Leadership in the New Millennium', 2009, p. 4.
[26] 'Developing Mining Leadership in the New Millennium', 2009, p. 6.
[27] Dale Benton, 28 June 2017, 'Global mining industry suffering a major skills shortage problem, Chamber of Mines finds', *Mining Global*. https://www.miningglobal.com/operations/global-mining-industry-suffering-major-skills-shortage-problem-chamber-mines-finds

Professional Skills for the Future of Mining: Industry Leaders' Perspectives

As technologies, regulations, environmental requirements and the talent pool evolve, among other considerations, so too will the skills and knowledge required of leaders in the mining industry. Through desktop research and by engaging industry and educational leaders, Swann has gained an understanding of the emerging demands of the industry and what will likely be required of its future leaders. Several key themes that emerged from this research are addressed below.

Technology, Data and Automation

Discussions with both industry professionals and academics indicate that the emergence of, and the need to embrace, new technologies is at the fore of considerations for the future of the industry.

Data was raised repeatedly as an area of emerging importance. As the mining industry works to become more efficient while also having to mine in more challenging conditions, it will be critical to collect and monitor data in real time, as well as analyse and use it to more effectively inform decisions. The industry will increasingly need those with knowledge of data collection, storage, monitoring and analysis, likely drawing on individuals with expertise outside of traditional mining disciplines.

Along these lines, one former mining CEO and current Board Director spoke about the move towards operating mines remotely, creating data centres that will enable more precise monitoring of the mines and allow a more diverse set of employees to work away from the 'coalface'. As companies move towards automation in the mines, industry professionals will not only need an understanding of traditional mining disciplines such as geology and engineering, but also those with general knowledge of IT as well as expertise in AI, robotics, and computer simulation.

Significantly, one professional noted that 'digital systems' knowledge must not come at the expense of understanding core aspects of mining engineering, mine design and planning, and geotechnical engineering, among other traditional mining disciplines. Thus, there is an expectation in the industry that future professionals should not solely draw on knowledge of mining disciplines or other industries but will instead need to have an understanding of a range of technological areas.

Sustainability

The professionals we surveyed also highlighted the increasing importance of sustainability, both environmental and social.

The ability to minimise energy and water use, track raw materials and work effectively with communities to gain societal acceptance were all specifically referenced as areas that mining industry leaders will need to develop and improve upon in coming years. These dimensions will be essential to acquiring social licence to operate in future endeavours and will likely play an ever more important part of the mining industry as new and increasingly rigorous environmental legislation is enacted in many mining jurisdictions.

Communication Skills

Along the lines of working effectively with communities, strong communication skills will be a fundamental feature of effective mining leaders of the future. One professional in our survey noted that the ability to deliver the 'right' message to stakeholders, both verbally and in writing, is becoming more and more important.

In the last year, for example, mining companies have had to respond to environmental and social disasters such as the Brumadinho tailings dam disaster, dozens of deaths (if not more) of illegal miners, governmental taxation disputes and general criticism of the environmental impact of mining, among a number of other incidents and concerns. Provided the current political and social climate, mining leaders will need to communicate more effectively than ever in order to overcome the critics and convey the benefits of the industry and its central position in modern technology and society.

In order to promote effective communication, mining companies will need to have greater interaction with stakeholders, which requires work across cultures and jurisdictions. Foreign language skills and an understanding of different cultures will also be key to obtaining social licence to operate in the future. Indeed, one professional cited the importance of 'strong skills in the humanities and social sciences.'

Awareness of Diversity and Inclusion

Further to being able to communicate with those from different cultural backgrounds, possessing a deep understanding of diversity and inclusion was also referenced as an important quality for future mining leaders to possess.

Eliminating unconscious bias and employing people with diverse background, skill sets, interests and capabilities brings a wealth of different perspectives to an organisation. Additionally, fostering a more inclusive environment and approach to hiring may help to mitigate some of the impact of the skills shortages.

Vision and Redefinition

Perhaps most importantly, the ability to not only recognise industry challenges but then to initiative change will be essential in future mining leaders. Problems associated with the mining industry's image will be addressed in greater depth in the next session, but the need for industry leaders to establish a new and more hopeful language around the mining industry's importance to progress and development will be key.

Leaders will need to be able to define and then tell a different story about the industry, encouraging others to recognise and promote its potential. As Mark Cutifani noted, 'the need to package our story in a very different way is the starting point for a new set of conversations.' These new conversations can shed light on the industry's centrality in creating new materials and applications that will make the world a better place in the future.

Engagement and Diversity: Perspectives in Mining Education

Student Attraction and Retention

Within higher education, academics are acutely aware of both the changing needs of the mining industry and of the impending labour shortage. However, in the same way that the cyclical nature of the mining industry has contributed to the labour shortage by limiting hiring – forcing professionals to go into other industries and dissuading individuals from pursuing academic coursework in mining-related disciplines – university courses in those disciplines have been cut in recent years and attracting students has been a challenge.

As such, it is not surprising that problems with student attraction and retention were consistently raised by the academics who responded to Swann's survey. Respondents provided several reasons for the lack of student interest in mining programmes both in terms of exploring the discipline and enrolment numbers. Prominent examples of which included:

- Cyclical nature of the industry, concern over the future of the industry and therefore uncertainty of getting a job after finishing university (as referenced above)
- 'The word MINING!' [and the negative perceptions that come with it in terms of environment, social issues, working patterns, etc.]
- Perception that the industry is family unfriendly due to FIFO, as well as being 'dark, dangerous and dirty'
- Relatively limited research funding opportunities for students when compared to other technical disciplines and industries such as oil and gas
- Conception of mining as 'old tech' rather than 'new tech'
- Concern over how mining companies have historically treated their employees (hire and fire mentality)

Significantly, while one respondent suggested that their institution only offered a *'small number' of industry-sponsored scholarships and that they 'would take more* [*students*] *if they had funding for their studies'*, the majority of those who responded were quick to suggest that scholarship opportunities were NOT the biggest hurdle in attracting students to mining degrees. Respondents noted, for example, that:

- Mining programmes offer 'the most affordable degrees on campus'
- Scholarships were offered to more than 70% of students in mining programmes
- Their institution offers a 'plethora of scholarship opportunities'
- Numerous scholarships are offered at different levels, based on merit and areas of need
- 'We have more scholarships available than are taken.'
- 'A number of mining companies and mining OEMs provide scholarship that help to encourage and support students throughout their engineering studies.'

Rather, a lack of funding for research and teaching, both in terms of traditional mining courses and in academic areas that are increasingly relevant, was referenced in all surveyed regions as being a major hurdle in developing and promoting research and programmes which would help to draw students, particularly at the postgraduate level, into relevant disciplines.

Responses suggested that:

- Their university had 'no large research activity in mining...at present' as a large mining centre sponsored by one of the largest mining companies in the world closed in 2016
- 'Unfortunately, mining programmes across the US are subcritical [not prioritised within the curriculum]. There is very limited research funding in this area and therefore universities do not see

mining as a priority. Hence, we have overburdened faculty who tend not to have the time to devote to cutting edge research and innovation. My department needs to triple in size.'

- 'The mining curriculum components are reducing – we do not get adequate support for students from industry to keep mining as core. I see more mining courses closing in the next few years.'
- 'It is hard to actively promote our graduate school when funding for research is small to non-existent. When we have a top undergraduate interested in graduate school, we work hard with industry partners to develop a funded project but this only eventuates in about 15% of our proposals. We have used unrestricted industry/donor funds in our Foundation account to fund some graduate students.'
- 'At this point we do not have a PhD programme and do not have funding for ongoing post-bach students.'

One individual also noted that his university has 'very limited resources for marketing [his] college', noting that they rely on the reputation of their programmes to attract students.

Thus, at a baseline level, universities struggle to attract students to the traditional mining disciplines before even beginning to address concerns around adapting their programming to the evolving needs of the industry.

Expanding the Curriculum: Multi-Disciplinary Approaches and Diversity

As suggested above, attracting students to mining is a challenge and thus universities are working to embrace new approaches to recruitment and programme development which incorporate and facilitate students from diverse backgrounds.

Looking to a range of STEM disciplines has proven to be a relatively natural area for universities to engage prospective students. Additionally, however, universities will also need to look to areas of study that are not conventionally part of the mining curriculum. By considering social sciences and humanities disciplines, universities will be able to better address some of the skills that are newly required by the mining industry, such as languages, communications and leadership, while also makes mining accessible to more diverse group of students.

The section below detail insights gleaned from Swann's research with regards to how universities are working to develop their curriculum and the sorts of the challenges they have faced in doing so.

Exposure to other STEM areas

Further to exploring very different areas, Swann's research indicates that mining departments are exploring ways to expose students to the full range of engineering disciplines (mechanical, civil, electrical, chemical) so that they have a background in aspects of engineering that are currently lacking from the mining curricula. One academic noted that his institution does not promote mining-specific undergraduate programmes as there is not significant demand for it. Rather, '*student*[*s*] *come into a general course and specialise. Very few top undergraduate graduates go into mining.*'

Another academic noted that his department is working to make the mining industry more attractive to STEM discipline students, which also relate to skills that the industry will require in the future. He said that they are working with the computer science and mechanical engineering programmes to build a minor which allows mining students to get into data management and computers.

While clearly some universities are looking to the future and working to bridge mining disciplines with data and tech, others responded with doubt and hesitation. For example, one of the respondents stated:

> *We strive to keep course content current with industry. It is hard to push further than that as the mining industry is not traditionally innovative. In a recent* Wall Street Journal *article it is*

> *noted that mining companies spend less than 1% of revenue on R&D whereas oil and gas companies spend 3-5%. I spent over 30 years in the industry and we dabbled with innovation. My last company had a growth in innovation, hiring several people with many not from a mining background and as soon as the commodity price dipped there went their jobs. Another large mining company spoke two years ago about Big Data and what they had planned, now it is not mentioned and most of those folks have sought other opportunities or are back doing the engineering job they did before being sucked into this Big Data exercise. I may have a jaundiced view but it is based on experience in the industry and not seeing mining companies stick to a long term path on innovation.*

Similarly, another academic noted that '*universities are playing their role…with double degrees such as mechatronics and mining*' in developing interdisciplinary courses that serve to meet the changing needs of the mining industry, but acknowledged that more can be done and that industry must lead in these efforts.

The financial challenge of developing new, interdisciplinary programmes was echoed in other responses as well. For example, one respondent from the UK noted that, 'we cannot afford the staff to teach small, specialised curricula. We would be very pleased to develop any such courses with the support of industry. To date we have had no approaches.'

Thus while the impetus to facilitate new programmes is a part of mining education, the ability to do so is limited, and potentially an area with which mining companies can assist.

Links to Humanities, Languages and the International Community

In order to do this, universities have begun to develop programming which is not only more accessible to those from different backgrounds but also provides training in areas that are newly required by the mining industry. Industry support for these initiatives would help to increase student numbers while also contributing to new areas of development.

Swann's survey showed that several universities are already working to develop interdisciplinary programming. As a relatively straight-forward example, degrees in Mining Finance and Mining Law are offered by a few universities. Similarly, the Department of Energy and Mineral Engineering at Penn State University in the US has created a programme that combines business management, engineering economics, mine design and finance. Thus universities are looking to offer programmes which fuse disciplines that are increasingly required by the industry as a whole.

Several other universities are merging disciplines in unconventional ways. The University of Utah serves as an interesting example as it is actively working to pair the humanities and sciences. More specifically, the Department of Mining Engineering is developing a BS in the Philosophy of Science, which is a joint humanities and geology offering, and has a new MS in Earth Resource Management. Ideally, this fusing of disciplines will not only allow students to gain 'soft' skills often associated with the humanities but will also help to attract those who weren't previously aware of, or involved in, mining-related areas.

Language skills are also being incorporated into mining degree programmes. The Penn State University has developed a centre which focuses on mining engineers from Latin America and includes immersive English language courses. With regards to international students and collaboration, one contributor to Swann's survey acknowledged that his university is 'developing dual degree programmes with universities in China, Taiwan, and India' and that they 'advertise in approximately 12 countries in South America, Asia and Africa.'

While it is clear that some universities are recruiting and collaborating internationally, the majority of respondents either declined to comment on their institution's recruitment of international students, or expressed the challenges they face when trying to do so. One respondent acknowledged that visas may be an

issue for international students wanting to attend universities in the US and Canada. He suggested that 'it is hard to attract foreign students without a hope that they may get a job, summer or permanent', clarifying that:

> *Generally, it appears as I have no empirical data, mining companies in the US do not hire non-USA or non-Canadian students for internships. My assumption is that they do not want to use an intern space for someone that they do not intend to hire. Students in the US on a student visa can work in the USA for up to three years after graduation to my knowledge.*

Therefore, in addition to working to attract more and diverse students from STEM disciplines, universities are looking to working to facilitate opportunities for students with diverse cultural and academic backgrounds in order to not only attract more students but also to ensure that academic programming adapts to the changing needs of the industry.

Conclusions and Possible Solutions

When starting this research, Swann set out to uncover information about scholarship programmes and ways in which the mining industry could potentially facilitate this sort of funding to help attract promising students to and promote engagement with the industry. Certainly respondents noted the value of such funding, recognising that scholarships 'help encourage and support students throughout their engineering studies.'

While the value and significance of scholarships was acknowledged, Swann's research suggests that the availability of scholarships is not the primary issue for those leading and developing mining education. Rather, suggestions have been made for industry to support other initiatives that would help to develop research, marketing and outreach programmes. Several key areas of opportunity were raised, which are detailed below.

Research Funding and Training

As detailed in the above section, a lack of funding for academic research and training is major concern in developing programming that would see future mining professionals develop relevant skills and attract new talent. Notably, several respondents suggested the importance of industry's role in developing these areas.

For example, one academic noted that he does *'not think universities should be driving these broader issues* [*industry leadership and innovation*]*, but industry should. They must offer more training and professional development in these areas.'* Similarly, respondents noted that *'they* [*mining companies*] *need the manpower for all the roles and so must take the lead'* and that *'industry must lead and I think they have until recently been slow in this regard.'*

Neville Plint, Director of the Sustainable Minerals Institute at the University of Queensland, spoke extensively on the ways in which funding research in the mining industry not only contributes to the development of new technologies and knowledge that will benefit the future of the industry, but also helps to attract and inspire students. He spoke passionately about the ways strong academic leaders can provide guidance, encouragement and direction for the next generation of mining professionals, suggesting that this is where investment should go in order to begin to remedy the skills deficit.

The importance of supporting academic development and programming was echoed in other responses Swann received. For example, one respondent to Swann's survey described a collaboration between his university and member companies on the Queensland Resource Council, in which they secured winter vacation work experiences for first-year engineering students. He explained that the opportunities presented through this collaboration encouraged a number of students to continue on with the second-year mining engineering programme.

Other initiatives have combined corporate, academic and governmental bodies. For example, in 2017, Northern Star Resources announced that they were investing AUD 50 million over ten years to support the development of an underground mining centre of excellence in Kalgoorlie. Inaugural partners in the project included Curtin University's Western Australian School of Mines (WASM), the Minerals Research Institute of Western Australia (MRIWA), METS Ignited, the Central Regional TAFE and the City of Kalgoorlie-Boulder.[28]

Thus companies and universities have taken various approaches to supporting and structuring academic programming and development at the university level. Further support for, and consideration of how to develop, such collaborations would continue to not only enhance developments within mining engineering but would also help to inspire students to pursue opportunities in the industry.

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[28] Kirstie Batten, 23 October 2017, 'Kalgoorlie gets new innovation hub', *MiningNews.net*. https://www.miningnews.net/leadership/news/1313978/kalgoorlie-innovation-hub

Partnerships, Early Years Engagement and Collaboration

In addition to investing at the university level, respondents suggested that industry support for school-level initiatives and professional development would also be of great value.

Early years education was repeatedly referenced as an area where funding from industry could be effectively utilised to generate and increase sustainable interest in the industry. One survey respondent noted:

> *...more needs to be done in middle and high schools to get students enthused about natural resources. Part of that enthusiasm would include activities for exposure, not just a presentation, follow-up so students get multiple exposures, and maybe a scholarship. This is why a partnership would be better as we are in the business of interacting with students and can tailor activities or presentation to the correct level.*

Another respondent noted that, '*collaborative partnerships are essential to encourage young people to consider careers in the minerals industry...*[*our university*] *collaborates with the member companies of the* [*regional council in Australia*] *to provide vacation work experience in mining environments.*'

In suggesting the importance of developing engagement programmes, it was noted that '*faculty already have a full-time job doing teaching, research and service to the profession.*' Furthermore, this individual suggested that '*Ideally a specific recruiter is hired to perform these interactions as it can take a long time to build the relationship to get into the middle and high school classrooms to do these activities'* and that '*middle and high school teachers have their own agenda to accomplish to meet their institution's goals.*'

Certainly there are institutions with this sort of arrangement in place. Montana Tech, for example was able to employ '*a person doing this type of role, building relationships with math and science teachers and getting in front of students, for a few years thanks to an NSF grant.*' Significantly, it was noted that this approach was '*successful in attracting students and the grant had a scholarship attached.*' Similarly, the Camborne School of Mines has a project officer who goes into schools and engages with students to promote mining-related disciplines at the University of Exeter.

Mining companies have recently started to employ a similar approach in terms of building relationships with school teachers in order to promote STEM disciplines. For example, Rio Tinto and Amazon have partnered together to launch an education fund that is aimed at promoting STEM subjects amongst school pupils. This project will identify education providers to work with Amazon Web Services, establishing start-ups and bolstering students skills in STEM areas. This innovative partnership is interesting not only because it marks significant support for STEM education at the school level, but also because a major mining company and a major tech company are joining forces to do so, signalling a willingness to consider different approaches to attract interest in mining.

Further to university and industry collaboration on outreach programmes, it was suggested that industry collaboration with government would be another effective way of promoting and developing the mining industry. As one respondent noted, '*universities and industries could partner better to lobby funding and government agencies to better support the academic field. We should also join forces to help the public and government appreciate that there can be no green revolution without mined minerals.*'

By way of an example of this type of approach, the Minerals Council of Australia hosts the Australian Minerals Industry Education Summit, which brings together universities, industry and government to work on collaborations which will help to solve the skills shortage problems. Other organisations, such as the previously mentioned Centre for Excellence in Mining in Canada, the Mining Essentials Initiative – which is run in partnership with Assembly of First Nations, the EMCN Engineers' and Technologists' Integration Program (ETIP) and the Centre for Innovation in Mining have also developed and run programmes to provide additional

training. Notably, such initiatives also help to encourage those from under-represented groups to gain skills relevant to the mining industry.

Companies have also invested in educational programming that is separate from schools and universities. In October 2018, Rio Tinto announced an AUD 2 million investment in Western Australia to forge a new vocational education and training (VET) curriculum, which is designed to prepare both potential and existing employees for technological innovation.[29] In this instance, Rio Tinto is working with South Metropolitan TAFE and state government to deliver courses that they feel will prepare the regional workforce for advancements and new requirements.

Thus collaborative programming, outreach and lobbying outside of academia are areas in which industry could contribute to the promotion of mining and development of future talent. These areas were much more commonly referenced than scholarships and, as evidenced throughout, models already exist for the establishment of partnerships and programmes.

Language and Marketing

Extending from outreach programmes, promoting mining more generally would be an area where the mining industry could make a valuable contribution. A 2018 poll conducted by Mining People International found that 70% of people polled thought that there was not enough done to promote the industry to high school and university students. Furthermore, 75% of people polled thought the responsibility of promoting mining belonged to the mining industry as a whole (with its organisations).[30]

A lack of awareness of opportunities within the industry and limited knowledge of the benefits of the industry were repeatedly referenced by those who responded to Swann's survey and interview requests.

Academics from both US and UK institutions emphasised that industry could support the marketing of mining-related programmes. One US academic noted that they are marketing 'as best as [they] can with limited budgets as the resources industry does not attract the large numbers of other programmes and a university must spread its marketing budget across all offerings.' A representative from the Camborne School of Mines described their ambition and strategy for rising up in university rankings, also highlighting the importance of industry contribution to university marketing.

One academic noted that:

> *Industry needs to encourage and support universities to "repackage" their mining engineering programmes in order to help them attract more diverse students. No matter how hard you try to explain the word mining, and the benefits of mining, it is not a word that immediately attracts the interests of a large percentage of students, particularly female students.*

Beyond helping to fund the marketing for academic programmes, industry can do more to combat negative perceptions and promote the positives and importance of mining; this would help to attract potential students and professionals. One US academic commented that *'the industry has been very slow to respond, they must lead with education following. They need to address a serious image problem that resources face. Only that way can the industry recruit the best and the brightest.'*

[29] 27 February 2018, 'Mind the gap: training mining workers for a digital future', *Mining Technology*. https://www.mining-technology.com/features/mind-gap-training-mining-workers-digital-future/

[30] Steve Heather, 31 August 2018, 'Data shows mining's skills shortage is biting – and industry is to blame', *Mining People International*. https://www.miningpeople.com.au/news/Data-shows-minings-skills-shortage-is-biting-and-industry-is-to-blame

Similarly, a UK academic noted that *'that is the role of the industry, to attract the best talent. This does not start when they graduate but before they start studying. We do not have the support of the industry to do this.'*

In essence, those who responded to Swann's surveys and interviews felt that it will be necessary to actively market both mining-related academic programmes as well as the mining industry. This is a major area of opportunity for industry contribution.

Critically, however, this change in how mining is presented and discussed needs to extend beyond just promotion of academic programmes. The industry needs to fundamentally change the language it uses both internally and externally to better articulate and demonstrate the centrality of the industry in societal development.

Mark Cutifani suggested that the entire industry required a 're-brand', noting that mining is only a small part of the story. Furthermore, he advised that abandoning the word 'extractives' would be a step in the right direction acknowledging that drawing associations with a trip to the dentist likely is not advantageous.

Rather, Cutifani stressed:

> *Our industry is about resource development and the understanding of natural sciences, material sciences and the creation of new products and applications to make the world a better place. Our products make life possible, we help to create new products for new applications – we are the raw materials for the creation of the future...Marrying resource development and new materials to Google and a whole new set of global possibilities is where we need to start a new story.*

Such a thorough reconstruction of the mining industry's narrative will need to be strategic and to come from the highest levels of companies. While it will require a concerted effort, this sort of fundamental change in language and vision will be a necessary component in creating future opportunities within the industry.

Final Conclusions

It is clear that professionals from both the mining industry and academia are concerned about the impending skills deficit. It is also apparent that industry support in different areas will be integral to finding a solution. While numerous approaches have been embraced by companies, universities and other parts of the public sector, several emerged from Swann's research as being particularly prevalent.

As mentioned previously, while scholarships to study mining-related disciplines were acknowledged as positive contributions, academics felt that the larger issues related to the perception of the industry and the competition it faces from other industries would not be resolved with scholarships alone. Rather four major areas emerged as ways the mining industry can make a significant impact through funding and engagement: These include:

- Funding academic research and training
- Building partnerships outside universities (e.g. school and vocational programming)
- Investing in the positive promotion of the industry and related subjects
- Adapting language at the highest levels to tell a different industry narrative

Improving on these areas will not only improve the nature and quality of training for those entering the mining industry, but will also inspire and attract new students from more diverse backgrounds to pursue education and careers which offer the opportunity potential to improve the world in which they live.

To discuss the report in more detail, please email swann@swannglobal.com or contact your nearest Swann office.