Female Mining Engineers: Strategies for Success

Executive Report
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Female Mining Engineers Literature Review
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EXECUTIVE SUMMARY

Highly skilled engineers drive many Australian industries including mining – a crucial Australian industry - in their pursuit of economic returns around the globe. Understanding the globalised context of Australian mining highlights the challenges of attracting highly skilled engineers to the often remote locations of Australia’s mining landscape. Despite the investment of educational and training resources over several decades, women’s engagement and progression in mining has been limited: only 13.4% of the country’s mining workforce are women. In Australia only 0.5% of mining’s managerial roles and Board positions are currently held by women.

The recent Women in Industry Awards (2015) suggest that women’s success in mining required them to be determined, tenacious, to take risks and to back themselves. Being knowledgeable and enjoying working in and mentoring a committed team was also key. The language of success in this industry suggests that women have overcome many hurdles and barriers along the way, yet these trials are rarely mentioned in reports, interviews or articles. The scarcity of women in the mining engineering industry suggests that understanding these hurdles, and the strategies that successful women adopt, may prove beneficial in encouraging girls and women to consider this profession and to support their ongoing success.

- Women’s capacity is clear: female student enrolments in Engineering and related Technologies courses around Australia have been consistently around 14% of total students for the past five years. Notably, once enrolled the completion rates for female students are higher than those of male students (female students are around 23% of the completing cohort compared to 75% for male students).
- Concerns about low female enrolment figures drove a $22m five year program launched in 2015: many tertiary institutions have set goals of 20 / 25% female student enrolment. ‘Choose Maths’ aims to work from the ground up in primary and secondary schools recognising that girls’ decisions about STEM careers take place early.
- There is a widely held perception that engineering cultures and workplace practices continue to be influenced by masculine attributes. The dominance of men in senior managerial roles supports this view although some girls and women are able to actively benefit from their distinction and difference in mining.
- Women in senior managerial roles value mentoring as a powerful strategy. They are explicit about their desire, and in many cases, overwhelming passion, to mentor female mining graduates. The ‘one on one’ nature of this strategy, supported by many professional female mining organisations, is widely acknowledged as playing a significant role in women’s success.
However, the individual nature of this approach may contribute to the lack of evidence of broader and/or systematic strategies to support women in mining engineering.

Figure 1: Numbers of Employees in Australian Mining Engineering Professions by Gender (ABS, Engineers Australia).

GENDER PAY GAP

The gender pay gap for mining professionals in 2014 is 27% and unfortunately for women with management aspirations, it increases with seniority. While the graph (Fig 2) reveals a slight reduction in the gender pay gap from 35% in 2012 there has been a persistent gap of around 30% since 2008. The duration and monetary value of the ongoing gap highlights the urgency of strategies to ameliorate the working conditions of female mining engineers and other female professionals in the mining industry. Interestingly, while the overall salaries of mining professions have dropped by 19% since 2012 the gendered gap has remained consistent.

Figure 2: Gendered Salary Gap between Women and Men in Mining professions by percentage (AusIMM, The Minerals Institute).
UNIVERSITY ENROLMENTS AND COMPLETIONS

According to statistics provided by the Department of Education and Engineering Australia the number of students enrolling in Engineering and related Technologies Courses has increased by between 3 – 5% per year from 2009 – 2013 (later figures are not yet available). The number of female students enrolling in these courses has remained consistent at 14% over the same period.

Despite a focus on encouraging females to enrol in Engineering, and other STEM tertiary courses (Science, Technology, Engineering and Mathematics), there has been no noticeable change to the gendered enrolment patterns in Australian tertiary institutions. Adding to the challenge of encouraging female students into engineering courses is the overall lack of understanding of the engineering profession in the general community (Engineering Workforce Study 2014).

It is widely considered that the number of women and girls studying in these areas in Australia is undesirably low. Statistics from other nations around the globe, including Finland, Canada and Russia, reveal more equitable participation for women in STEM courses. Once enrolled though, female students in Australia are more likely to complete their studies: completion rates for female students improve to 21-25% of the overall student cohort while male student completion rate falls to 75 – 78%.

Figure 3: No of Domestic Students Commencing Engineering and Related Technologies in Australian Universities (Engineering Australia).

Figure 4: Numbers of Domestic Students Completing 3yr Bachelor Degrees in Process and Resource Engineering in Australian Universities (Engineering Australia).
Providing young Australians with high-quality, equitable education in STEM related subjects during their primary and secondary school years is a national priority for the Australian Government. The low participation of girls and women in STEM subjects and courses at a tertiary level remains a significant concern. The lack of highly qualified teachers is offered as a reason but equally so is the girls’ lack of awareness of STEM professions. It is argued that girls are more likely to recognise a career as a doctor or research scientist than an engineer or mathematician. Research shows that those with family connections to the mining and engineering industries were more aware of STEM career opportunities (de Cohen and Deterding 2009, Kittle 2012).

Australia is not facing this dilemma alone as the shortage of girls and women in STEM careers is acknowledged around the world. Many nations have developed dynamic and productive strategies to address the issue. Australia is developing its own policies, but may be lagging behind the world leaders and needs to move quickly to stay in touch with major global players. The shortage of girls and women is not just a gender based issue, if action is not taken Australia faces on ongoing shortage of STEM skilled professionals. The mining industry faces its own unique challenges as mining activities are considered to be culturally specific. It is important that Australia continues to educate mining engineers as overseas trained professionals may not have the localised knowledge and cultural training required by Australia’s mining industry.

In April 2015 the Australian Mathematical Sciences Institute (AMSI) and BHP Billiton Foundation responded to the demand for action and joined forces to launch a $22 m five-year national program, Choose Maths. The program is aimed at turning around public perception that mathematics and statistics are not career choices for girls and young women. Choose Maths will work from the ground up, focussing on mathematics education in primary and secondary schools. A key aim of the program is to encourage girls and young women into STEM courses. International studies suggest that girls are making decisions about careers well before their enrolment in tertiary institutions and information in the earlier years about STEM careers is well placed (Buschor et al. 2014).
GOVERNMENT AND INDUSTRY INCENTIVES

There are many organisations in Australia and internationally supporting women in the mining industry. These range from the global Women in Mining which has multiple associated bodies in many mining nations and State affiliates in most Australian states. The Australian Women in Resources Alliance and the AusIMM’s Women in Mining Network also provide support for female mining professionals. These organisations have primarily been established to support women through shared experiences, attending networking events and building their professional networks. Many have two key bodies; female mining professionals and female partners of miners.

Many offer formalised mentoring opportunities for new female mining engineers. Many of the state based WIM organisations offer mentoring to young female mining graduates as well as supporting them with membership, information, peer support and a reference point for guidance. The value of mentoring newly graduating female engineers is well entrenched within the mining profession in Australia and around the globe. Many of the senior women recognised for their success, including those identified as part of the 100 Inspirational Women in Mining in 2013, reflect on their desire to pass on their knowledge and experiences. A MENTOR WHO SUPPORTS A NUMBER OF WOMEN IN THE ENVIRONMENT. SHE CALLS IT A SISTERHOOD. FEELS STRONGLY THAT WOMEN CAN ACHIEVE HUGE SUCCESS IN MINING IF THEY ARE PERSISTENT, SUPPORTED BY EACH OTHER AND KNOW THAT THERE ARE WOMEN WHO HAVE WALKED THE ROAD AND HAVE THE ANSWERS (100 GLOBAL INSPIRATIONAL WOMEN IN MINING 2013).

This is a very generous and obviously successful strategy: yet there is an assumption that only women can support each other and understand the unique journey they take in this industry. The one on one context of this strategy may be the reason for the limited systematic evidence of the broader strategies senior female mining managers use.

Accepting her award as winner of the 2015 Women in Industry, Excellence in Mining, Maria Joyce revealed her commitment to mentoring and supporting other aspiring mining engineers to make a difference in the mining industry. The judges provided some insight into the attributes they valued in Maria as a senior female mining engineer/manager, describing her as:

The General Manager actively mentors females within the industry, and is passionate about engaging and teaching young girls and women around the opportunities and possibilities that are within the resource sector. She actively demonstrates the possibilities of rewarding roles to be conquered with a bit of effort and drive (100 Global Inspiration Women in Mining 2013).
Clearly a successful role model for women in the mining industry, the comments don’t however reveal details of the strategies she has adopted or the hurdles and obstacles she has overcome to succeed.

Recognising the need to encourage women, mining organisations are responding financially as they encourage and develop female leaders across the resource sector. Women in Mining Network, WIMnet is offering scholarship grants in 2015 to subsidise leadership development for women. Those working in resources and engineering sectors in Senior Management and Executive levels can apply for $12,000, Managers can apply for $4,500 and women at all management levels can apply for subsidised seats at a number of symposiums being held around Australia.

Iron Ore giant, Rio Tinto has made a commitment to improving the gender diversity in its Australian mines. It set a target in 2010 to have 20% women in senior and executive leadership roles by 2015. Achieving this target required the mining giant to identify 50% of its female middle management as being highly promotable.

In 2013 the Australian Human Rights Commission addressed the shortages of women in male dominated industries by releasing Women in male-dominated industries: a toolkit of strategies to increase recruitment and support retention of women in male-dominated industries. The tool kit covers all industries, but has a particular focus on attracting girls and women into traditionally masculine workforces such as mining, construction and utilities.

**TERTIARY INSTITUTION INCENTIVES**

Australian Universities offer a range of scholarships in Mining Engineering, some of those offered in 2015 include;

- **Monash Mining Engineering Scholarship.** $6000 pa. Scholarship to support Mining Engineering degree.
- **University of Queensland/Rio Tinto Mining Engineering Scholarship.** $10,000 pa. for 2nd year students, preference for Indigenous or female applicants.
- **Curtin University, Western Australia School of Mines** $12,000 pa. Scholarship to students studying Mining Engineering but experiencing financial difficulty.
Australian Universities also offer scholarships or opportunities to inspire girls to pursue careers in the engineering profession.
In 2015 these included;

- Monash University, Women in Engineering, $5000 Bursary Scholarships.

Monash University offered 50 Women in Engineering Scholarships in 2014 and again in 2015. In 2014 only 37 Scholarships were taken up, with two of those for Mining Engineering specifically. In 2015, 34 Scholarships were awarded, with none specifically for Mining.

Offering up to 50 scholarships to celebrate the success of high achieving female students who choose to pursue a rewarding career in engineering.

Analysis of Monash’s Engineering intake by gender suggests the scholarships may have had a small impact on the numbers of female student enrolling in 2014.

For the first time in 5 years over 20%, see figure 5, of the undergraduate enrolment for Engineering courses was from female students.

- The University of New South Wales, Faculty of Engineering has set a goal of 25% female enrolments by 2020 (currently 20%). The Faculty runs day-long engineering workshops tailored for girls on campus throughout the year. The University also hosts a camp for female secondary school students.

- The University of Queensland’s Women in Engineering program is a leader in Australia with an undergraduate engineering student cohort of 24.4 per cent in 2014. The programs goal is to increase the undergraduate engineering female enrolment to 30 per cent by 2023. The program largely centres on its comprehensive secondary school outreach program. It introduces and inspires female high school students to consider engineering studies through on-campus and in-school interactive workshops and expos.

The camp has allowed me to fully understand what engineering is and has answered questions about my career goals. Also, meeting like-minded women has further motivated me to pursue engineering. (Camp participant 2013).

- The University of Queensland’s Women in Engineering program is a leader in Australia with an undergraduate engineering student cohort of 24.4 per cent in 2014. The programs goal is to increase the undergraduate engineering female enrolment to 30 per cent by 2023. The program largely centres on its comprehensive secondary school outreach program. It introduces and inspires female high school students to consider engineering studies through on-campus and in-school interactive workshops and expos.

Figure 5: Number of undergraduate students enrolling in Engineering at Monash University, analysed by gender.
- Programs designed to inform girls about Engineering as a career appear to be making a difference.
- The programs implemented by The University of New South Wales (UNSW) and University of Queensland (UQ) appear to be achieving some success in informing girls and young women about the possibilities and opportunities available to them in Engineering or STEM professions.
- Of the 12 participants in the 2013 UNSW camp, nine enrolled in engineering at the University the following year. Many more girls gained valuable insights into engineering by attending the day-long workshops on campus throughout the year.
- UQ appears to be achieving similar results, their program of an Exploring Engineering Day for girls and an Engineering Futures Evening engaged with over 600 female high school students in 2013, its first year of operation.

THE REMOTENESS OF MINING: FLY-IN, FLY-OUT (FIFO) OPTIONS

The majority of Australian mining takes place in remote parts of our country, particularly in Western Australia, New South Wales and Queensland. Many mines sites are located long distances from towns which provide workers with the necessary infrastructure to establish lives outside of work for themselves, and their families. Long distance commuting (LDC) such as fly-in, fly-out (FIFO) or drive-in, drive-out (DIDO) arrangements and flexible shifts/rosters have long been a part of the Australian mining landscape. It was estimated in 2014 that around 50% of the mining workforce in Western Australia is employed under FIFO arrangements.

Figure 6: Distribution of Australian coal mine locations. (www.miwer.org/research/category/mine/).
The flexibility of the practice enables families, or individuals, to establish homes and lives in cities, such as Perth in WA. Workers report many positive experience working FIFO; they like the job, salary, job security, length of shifts and flexibility of roster systems. Yet there are identified limitations in integrating this work with other life objectives. These generally sit within two key areas, organisational factors (rosters, work culture) and personal ones (career aspirations, family circumstances). Concerns about the impact of FIFO practices on health and wellbeing are well documented. The incidence of mental health issues and suicide amongst FIFO workers prompted Western Australian and Queensland State Governments to conduct inquiries into the impact of FIFO work practices on mental health in 2015.

While women are readily acknowledged in FIFO studies and reports, their experiences are most commonly explored as that of the ‘mining missus’ or ‘mining widow’ whose partner is employed is at a FIFO mining site. Where professional women are included in broader studies their participation is acknowledged but responses are not analysed separately.

SHE HAS BEEN LIVING THE FIFO LIFESTYLE FOR THE PAST 18 YEARS AND SAYS WORKING FIFO IS A PERSONAL CHOICE THAT HAS CATERED EXTREMELY WELL TO HER LIFESTYLE. LOVES WORKING FIFO, WITH DAYS OFF I HAVE A GREAT WORK/LIFE BALANCE (MANAGER, AUSTRALIAN MINE).

Reports such as the Western Australian study (Brown et al. 2014) of 170 FIFO workers, with 17% women (including 16% managerial) and Queensland (Barclay et al 2014) study of 286 FIFO workers, with 58% male and 32% female respondents, missed an opportunity to analyse women’s experiences independently. As the numbers of female mining professionals increase, recognition that their FIFO experiences differ from those of their male colleagues the significance of developing separate understandings should generate gender specific studies. In the meantime we are reliant on small scale studies to provide some insight into the issue female mining employees experience working within FIFO arrangements.

The small number of women included in a WA (Meredith 2012) study highlighted the suspension of their home responsibilities, relationships, significant milestones or events, and even the decision of when to start a family as challenges they face in FIFO employment. They acknowledged that the support their extended family gave them helping to make this employment arrangement feasible. Reflecting on their experiences with on-site FIFO accommodation a small group of female workers in a qualitative study found the FIFO arrangements to be isolated and lonely and said they found it difficult to make and maintain friendships. They described the time on site as being physically, emotionally, and psychologically demanding.

The Western Australian Government (2015) highlighted the same issue in its investigation of the impact of FIFO work practices on mental health. The report also highlighted the specific challenges of women, stating they ‘would welcome further information on the particular mental health issues that women face while doing this form of work’.
WORK-LIFE BALANCE

It is difficult to find evidence about how women in senior management roles in mining engineering balance the demands of work and life. Even in the 100 Global Inspirational Women in Mining Report children and families were acknowledged but the challenges women faced and their success strategies are not included in their biographies. As noted above, their desire to mentor and pass on their knowledge and help other female mining professionals to ‘walk the road’ is prominent. Issues that have been raised in reports and articles are the distance and remoteness of mine site, including the necessity for FIFO arrangements, child care accessibility and career breaks.

A contrasting perspective is evident from the female focus group participating in the Engineering Workplace Study conducted in (AWPA, 2014). They suggested that being a women was a ‘bonus’ in some instances as employers seemed to be keen to employ female engineers. They also reported positive experiences in the workplace where they felt that women were respected and treated as equals. The idea of mentoring, peer support groups and flexible work options were identified as supporting women to stay in engineering. They suggested that some countries offered better supports for women than Australian workplaces.

Rio Tinto Iron Ore identifies possible challenges:

- Flexible work arrangements policy for all employees,
- All requests must be given due consideration on a case by case basis,
- Part-time employment,
- Job-sharing,
- Phased retirement,
- Flexible working hours,
- Coaching to educate leaders on the commitment to flexible working arrangements (WGEA 2013).
THE GENDERED LANGUAGE OF MINING?

For many young female mining engineers their positive experiences and success at University are not reproduced in their workplace experiences. While some unease in the workplace may be attributed to inadequate facilities, much of their discomfort comes from the perceived need to ‘act as men’ or adapt to the ‘boys club’ mentality in this traditionally masculine environment. The culture and workplace practices of engineering continue to be influenced by masculine attributes and behaviours (Male 2014). This pattern appears to be particularly prevalent for women in senior managerial roles in this highly masculine environment. However this same environment is also considered to offer female mining engineers an advantage as it can be seen as an opportunity to help them to stand out from their male colleagues. In either scenario gender is significant.

Being female, or a ‘girly girl’ in the mining industry is considered by some women to be disadvantageous. The review by Mayes and Pini (2010, p.234) of media reports of women in mine management roles from 2006 – 2008 revealed the need to neutralise femininity, with many seeking to distance or dismiss their femininity and instead position themselves within discourses of gender neutrality. In an ironic twist the scarcity of women engineers in senior mining management roles dictates that they are highly visible in the industry, yet may be compromised in their ability to reveal themselves as ‘real women’ and they learn how to conceal their ‘femininity’ (Faulkner 2009). While there are limited studies with female mining engineers entering the field from 2010 onwards, a number of earlier studies with female mining engineers, and other STEM roles, highlighted the need to justify their position when asked about their motivation to pursue a career in engineering, as ‘real women’ do not aspire to belong in this profession (Faulkner 2009). There is further evidence that women in ‘non-traditional’ roles such as engineering are still considered to be less physically able, inept and more focussed on family commitments than their work environments (Engineering Workforce Study 2014).

Despite the dominance of masculine practices and a ‘boys club’ culture that recent studies and industry reports report throughout the mining industry, there are female mining engineers who express their enjoyment of working in this male dominated environment. For some the challenges they face in this environment are embraced and may contribute to the robust work ethic and resilience that have been identified in successful female engineers in management roles. Being a minority in this diverse and dynamic industry is not always considered a negative for female mining engineers (PWC, Mining for Talent 2015).
FEMALE ENGINEERING STUDENTS’ EXPERIENCES

Female students studying Engineering and other STEM based courses in tertiary Institutions often report that their decision to enrol was influenced by experiences or interactions from their earlier childhood years. Many said that the influence of parents or family members who had a connection or employment in STEM Industries played a role in informing them about the opportunities in the profession.

The motivation of a mentor is considered as important for female students in many countries around the globe (Kolmos et al. 2013). Teachers who took a particular interest in their maths or science based subjects and affirmed their ability in these subjects were also acknowledged as influential in girls’ career decisions. Being good at maths, science technology, and engineering subjects can be the motivating factor as well as providing the leverage into tertiary studies (Barnard et al. 2012). An awareness of the engineering profession and the types of choices available is important to girls making decisions about pursuing careers in the STEM field. A UK study (Powell et al. 2012) found that ‘engineers solving problems for developing worlds and disadvantaged people’ was attractive to girls and women who describe wanting to do something different in their working lives.

Making a choice about a career in any profession at the end of the secondary years can be a complex and often perplexing process. Many students, across a range of studies and nations, considered that engineering was a masculine environment and there are innate gendered attributes that make men more suitable and women less so for studying (Kũskũ et al. 2007). Others suggested that the male domination in the industry was off putting to many girls and women. Once enrolled though it appears that many women who study and work in STEM based industries are proud of their place and success in these male-dominated fields.

Current female engineering students share their enjoyment of being in the minority, I was one of three girls in my year, I had a great time’. Others felt that their gender would increase their employability as they recognise that employers are actively seeking women to improve the diversity of their workplace (Powell 2012). There is evidence though of conflicting stereotypes with some students questioning a girl’s or woman’s suitability for the ‘masculine’ work of engineering while at the same time endorsing the idea that anyone can work in the industry if they want to (Powell 2012).
THE VOICE OF THE FUTURE - YOUNG FEMALE MINING ENGINEERS’ EXPERIENCES

Young female mining engineers, graduating and joining the mining workforce since 2010, describe being in a male dominated industry as a positive, albeit challenging experience. Their comments suggest that many female mining engineers are optimistic about their work environments and embrace the challenges that confront them. It should be noted though that these comments are expressed by female engineers selected to market their own employers or the mining, engineering industry more broadly and it is difficult to make the assumption that they speak for all. As a result it is difficult to have a clear view of the everyday experiences, challenges and career pathways for newly employed female mining engineers in Australia or internationally.

CONCLUSION

Our findings suggest that the preferred practice for supporting girls and women in the Australian mining industry is mentoring. While this practice is clearly successful, it limits direct discussion and knowledge of the barriers and challenges successful female mining engineers face and how they overcome them. Combined with the pressures on women to ‘act like men’ in this masculinised industry, the opportunity to capture and disseminate the strategies of successful female mining engineers is even further restricted. It may be necessary to consider alternative explorative methods with women to begin to identify the barriers they
overcame and the strategies they adopted throughout their career. We suggest that valuable understandings already exist in the industry and academia in studies and research into the lives of mining professionals and managers, particularly in respect to experiences of Fly-In, Fly-Out practices. Our explorations suggest that studies have captured gendered data but have not yet analysed their results to systematically identify barriers and strategies to overcome them.

In relation to the numbers of females enrolling in Mining Engineering courses we found that the key focus, as has been identified by the Australian Government, and Mining Organisations, should be on exposing girls in primary and secondary school environments to the benefits and opportunities of pursuing a career as a Mining Engineer.

RECOMMENDATIONS

- Identify existing studies of mining professionals’ experiences which could be re-analysed from a gendered perspective.
- Generate new studies which focus on the barriers women have experienced throughout their career and the strategies they adopted for success.
- Acknowledge the success of mentoring throughout the industry but create new studies that focus on alternative incentives or opportunities for new female mining engineers negotiating a career.
- Recognise that many newly graduated mining engineers are happy to share their stories on social media and other forums. Identify key narratives of these new engineering graduates negotiating their pathway from home, primary, and secondary schools into the mining profession to share on Monash University’s Faculty of Engineering website.
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BIBLIOGRAPHY


APPENDIX - 2006 CENSUS DATA: WOMEN, EDUCATION AND ENGINEERING

Data from the 2006 census reveals:

- Over half of the female mining engineers in Australia are aged under 30.
- Female mining engineers represented only 6% of those earning in excess of $2000 per week.
- The majority of female mining engineers are degree or postgraduate degree qualified, very few achieve their qualifications through Diploma or Certificate Qualifications.

![Figure 7: Percentage of Professional Australian Mining Engineers by Age and Gender - 2006 Census](image-url)
Figure 8: Percentage of Australian Males and Females Employed in Professional Mining Engineering by Weekly Income – 2006 Census.

Figure 9: Percentage of Australian Mining Engineers by Gender and Highest Level of Education – 2006 Census.