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Will the Head of Engineering Please Stand Up? the under-representation of women in engineering

Introduction

Gender segregation in the UK labor market is persistent and partly the consequence of little change in the numbers of women employed in male dominated industries. A number of these industries, some of which are economically critical, are facing skills shortages, which could be addressed through the recruitment and retention of more women (Munn, 2014). There are currently 14.7 million women in employment in the UK (Deloitte, 2016) out of a total workforce of just over 30 million. While women have entered some previously male dominated professions in greater numbers such as human resources and law, they comprise just 13 per cent of the STEM (science, engineering, technology and mathematics) workforce, 11.5 per cent of STEM managers and just 5.7 per cent of engineers (WISE, 2015).

This chapter examines a highly gender segregated area of employment – engineering – a profession where this segregation begins at school, continues through to the workplace and is underpinned by gender stereotypical views of what constitutes, ‘men’s work and women’s work’ (Bradley, 1989). The chapter offers an insight into what life is like for female engineers, specifically in relation to their numerical under-representation, how they think women engineers are perceived and the challenges they face as female professional engineers in male dominated workplaces.

The chapter begins by presenting a general picture of the engineering sector, focusing on the aviation and aerospace industry. We then briefly review extant literature on women in male dominated industries and engineering in particular. After a brief explanation of the methods used, we then present and discuss empirical material collected through 16 semi-structured interviews with female engineers who work in the UK aviation and aerospace industry, in an attempt to understand their work experience, challenges and perceptions about how women are viewed in the industry.

Engineering and the aviation and aerospace industry

The engineering sector is important to the UK economy, contributing 27.1 per cent of the total UK Gross Domestic Product (GDP) and employing over 5.5 million people with approximately two thirds being practising engineers and technicians (Kumar *et al.*, 2016). Employers report a skills shortage in the sector, especially at technician and graduate levels, which is exacerbated by the majority of young women not choosing a career in engineering and half of those who graduate with engineering degrees choosing not to follow an engineering career. This leads to a lack of gender diversity and the underutilization of the female workforce. The UK compares poorly to other EU countries, such as Latvia and Sweden where women make up 30 per cent and 26 per cent of engineers respectively (Kiwana *et al.*, 2011). It is claimed that increasing the numbers of women in STEM employment could contribute an additional £2 billion to the UK economy (Kumar *et al.*, 2016). This skills shortage could be addressed by encouraging more women to join the profession and thereby enable employers to improve

their 'bottom line'. But is this an attractive proposition for the women themselves, deterred by engineering's masculine image? Do the gendered power relations and the masculine culture in engineering need to be challenged before more women will set foot in engineering (Sharp *et al.*, 2012)?

The shortage of women engineers and the segregation of women within it, begins in education and is reflected in employment figures. 'Leaks' in the pipeline of potential engineers begins at 'A' level¹ stage for women as just 20 per cent of physics 'A' level students are girls (Institute of Physics, 2012). Girls tend to become attracted to engineering at the age of 11 but lose that interest by the age of 14, believing it to be 'unglamorous and anti-social' (Kumar et al. 2016). Poor careers advice and unacceptable stereotypes about STEM jobs, amongst other factors, means that many girls are not choosing engineering. Despite first degree achievements in engineering and technology being at an all-time high, just 15 per cent of those degrees were awarded to women and just over half of all female engineering and technology graduates entered engineering jobs. This is compounded by engineering attracting the lowest proportion of female applicants in the first place (Kumar et al. 2016).

The aviation and aerospace industry, where we conducted our research with female engineers, is particularly significant to the UK, contributing around 1.2 per cent of the total GDP and employing 300,000 directly and 700,000 indirectly. The industry has a persistent, on-going skills shortage which could be addressed through recruiting and retaining more women (RAeS, 2009; Munn, 2014). However, in this industry, women tend to be segregated into occupations that are

¹ 'A' Level is a school leaving qualification used in the UK.

gender typical, such as clerical, administrative, sales, human resources and marketing and remain very poorly represented in the industry-critical jobs such as pilots, senior managers, directors and, crucially, engineers. Interestingly, the Royal Aeronautical Society (RAeS) which represents the aviation and aerospace industry, welcomed its first female president, Jenny Body, in 2013 and has a Women in Aviation and Aerospace Committee. The industry however, remains one of the most under-represented for female engineers and the second least likely destination for a female engineering graduate.

Women in male dominated industries: challenges, barriers and stereotypes

This begs the question, why are women being deterred from following a career in engineering? Women who work in male dominated industries face challenges that differ from those who work in female dominated or gender balanced industries and sectors. Martin and Barnard (2013) argue that these challenges either emanate from organizational practices that, overtly or covertly, perpetuate discrimination, or from women having unique, physical, work-identity and work-life balance needs that are not recognized in male dominated environments.

Many of these challenges and barriers to progression emanate from what Bradley (1989, p. 69) calls 'gender work environments' or 'work cultures', which both reflect and enhance segregation. Women in male dominated industries may also feel that they are not accepted into certain roles, especially those that have been historically maintained as 'masculine' through masculine organizational practices (Mills, 1998; Neal-Smith and Cockburn, 2008; McCarthy *et al.*, 2015).

Women end up being stereotyped as emotional and less committed to their work

than their male colleagues (Von Hippel, 2015). There is also a lack of role models, mentors and networks that could act as a means of support for women (Germain *et al.*, 2012). Women thus find themselves having to prove their suitability for the job and to challenge the masculine norms in their industries and workplaces (Woodfield, 2015).

The culture of presenteeism, long working hours and the expectation of infinite availability have also been identified as barriers to the retention of women and their progression in male dominated industries. In a study of women working as civil engineers in the construction industry, Watts (2009) found that success was linked to being able to fit into these features of the dominant masculine culture and that the issue is experienced as particularly stressful by women with family commitments. Moreover, despite the introduction and development of family-friendly policies and legislation in the UK, combining work and caring/domestic responsibilities remains a persistent problem for the majority of working women who still perform the majority of domestic and child-rearing responsibilities in the home, regardless of class or occupation (Sullivan, 2000). Almost half of women in employment work part-time, which has been linked to low quality work and with fewer possibilities for promotion (Durbin, 2015; Durbin and Tomlinson 2010; 2014). Working part-time still carries a stigma, with part-time workers being considered uncommitted or peripheral (Alvesson and Billing, 2009) and impacting negatively on one's professional identity (Watts, 2009).

All of these factors lead to a 'leaky pipeline', with the continuous loss of women as they progress in STEM careers, underpinned by the prevalence of gender stereotyping (Damaske, 2011). Although connected to the experience of women in

employment, stereotyping predates a person's entry to the labour market, starting early on, in the way boys and girls are socialised in the family and schools (Jenkins, 2004; Powell, 2011). While stereotypes also affect men, they are more detrimental for women because they can limit women's aspirations and occupations (Heilman, 2012). The gender stereotypes are particularly harmful for women's occupations that seem to 'fit' with descriptive stereotypes about men and 'not to fit' with descriptive stereotypes about women (Caleo and Heilman, 2014). This may lead to some women adopting masculine attributes, although they may find themselves in a new predicament, as they risk being seen as violating gender-normative expectations. Women in male dominated industries may feel a disproportionate need to prove themselves when compared to their male counterparts (Smith, 2013).

Women in Engineering: an overview

Entry into the engineering profession follows several years of post-compulsory education and on-the-job professional workplace training. The low numbers of women in SET occupations have been well-documented (Evetts 1998; Fox and Stephan, 2001, Herman *et al.* 2012). So why do women stay in engineering? Buse *et al.* (2013) claim this is because female engineers are adaptable and have high levels of efficacy, identify as engineers and are motivated by the challenges of being an engineer but they also found that these women are less likely to be married and to have fewer children. In a study of female engineering students, Powell and Bagilhole (2006, 2009) found that their interviewees accepted gender discrimination, viewed the industry positively, valued their novelty status, were

critical of other women and acted like 'one of the boys'. They argue that this indicates women may be assimilating to the dominant male culture and/or share the attitudes and values of their male colleagues or are 'fronting it out' (Evetts, 1998) to become accepted by their male colleagues.

Engineering has been described as a 'masculine' profession that is unsuitable for women, as it is perceived as being 'tough, heavy and dirty' (Powell and Baglihole 2006). Gender stereotypes of this nature have long functioned as exclusionary mechanisms. Holth's (2014) study of IT engineers demonstrates that while stereotypes can be challenged, entering an engineering career can be seen as a 'straight road' for the men, following a natural connection to technology and as a 'winding road' for women as it is seen as 'gender inauthentic' with women often asked to justify their career choices. Conversely, Cech *et al.* (2011) argue that the problem is that when compared to men, women tend to lack professional role confidence that contributes to more women leaving the profession. Cech (2015) points out that men and women develop somewhat different professional identities and this has an impact on men's and women's intentions to remain or leave engineering.

Various strategies to try to increase the numbers of women entering engineering education and employment have enjoyed limited success (Durbin, 2010; Powell *et al.* 2008). Government initiatives include the setting up and funding of Women in Science and Engineering (WISE) to tackle women's under-representation in science and engineering with a target to increase the numbers of women to 30% by 2020. On current figures, this looks challenging, particularly as funding to

bodies such as WISE has been progressively cut and little has been done to address the lack of flexible working in some of these industries. Despite all of the above, there has been no significant advance in the diversity of the sector. One of the authors of the UK Engineering (2016) report argues that the participation of women in engineering must change (Kumar et al. 2016).

Methods

The data in this chapter is based upon sixteen semi-structured interviews with female engineers (pseudonyms are used to protect their identities) in six large engineering companies in the aviation and aerospace industry. Interviewees are employed in a variety of engineering roles and at different levels such as professional or manager, spread across the UK public and private sectors (see Participant Table below). Interviews were conducted between February and May, 2015, predominantly face-to-face in the interviewees' workplace with a small number by telephone. Interviews lasted approximately one hour and explored the interviewee's career history, experiences and challenges associated with working in a male dominated industry and the availability of mentoring support. Interview data was analysed by a team of three researchers, using thematic analysis, an approach chosen due to its embedded flexibility as it allowed us to follow pre-chosen themes that guided the interview questions as well as enabling us to spot emerging themes. The following section explores these themes in more detail.

[TABLE ONE HERE]

Findings

Women Engineers as ‘Tokens’

To set the context, we asked interviewees to identify the approximate percentage of female engineers in their organizations, estimates ranging from 5-10%, which were in some cases higher than the industry average (WISE, 2015). We then asked interviewees whether they felt that this lack of women’s presence had any impact for women in the profession and several felt it did. As an example, Nancy found it difficult to encourage more girls to become interested in engineering as part of her outreach work with schools and further that there were challenges associated with returning from maternity leave and working part-time that she felt would perhaps not be an issue in a more gender balanced industry. A lack of female role models was an issue for Paula, who felt that there was a ‘prototype’ of personality which normally made it to the higher grades.

Interviewees were clearly aware of their token status and were able to cite several examples of how this manifests itself when trying to attract and retain women in engineering. Interviewees then told us their views on why women are so poorly represented in their industry.

The Under-representation of Women in the Industry

The poor perception of engineering as a profession in the UK, a lack of focus on engineering in schools/poor careers advice, the physical demands of the job and speculation about women planning families, which often did not fit in with a masculine work environment, were amongst the reasons cited by interviewees for under-representation.

Comparisons with other countries revealed an awareness of a much poorer representation of women in engineering in the UK. Maria, Cristina and Paula, all of whom had studied or worked abroad, pointed out that it was more acceptable for women to become engineers in other European countries. This, they reflected, could be 'a cultural issue', especially at university where numbers of women studying engineering are higher and engineering as a profession is more highly regarded than in the UK. One reflected that this may be due to a combination of the education system and social perceptions of what is an acceptable occupation for women.

Poor schooling, a lack of careers advice and the consequent mis-understanding of the role of an engineer were offered as some of the main reasons for women's poor representation (Institute of Physics, 2012; Kumar *et al.*, 2016). Jennifer articulated that this was possibly connected with both the 'preconditioning' of girls to consider certain roles and the belief that they should emulate their mothers and sisters to do things such as caring (see Jenkins, 2004; Powell, 2011). She felt that women had to be a little non-conformist to follow an engineering career. For Helena, the main issue for women was that as children, engineering was seen to be male related, which she felt pushed women back from choosing an engineering career. Donna's awareness of engineering was sparked by a close male relative, which she notes was quite common for other female engineers she had spoken to. Her belief was that women had to be 'quite thick skinned' to survive in engineering. Ruth and Pamela also thought that the problem stemmed from engineering being perceived as a traditionally male environment and the perceptions of what women can and cannot do starting at school age.

Military engineers identified slightly different reasons: the physical aspects of the job and being posted to other countries, irrespective of whether the woman had children. Brenda and Pamela had recently had to make a choice between their next posting and a promotion (respectively) or starting a family. They both chose future career progression, their intention being to start a family once they had gained promotion.

How Women Engineers are Perceived by Others

Women's under-representation in engineering was also linked to how the interviewees felt women engineers were generally perceived by others. This included the perception that engineering was a 'masculine' occupation with 'masculine characteristics' being required to do the job (Neal-Smith and Cockburn, 2008; McCarthy *et al.*, 2015) that women entering this male-dominated profession were 'unusual' and 'different' and that being on the receiving end of men's derogatory comments was part and parcel of being a female engineer.

Linda felt that the perception that engineering was 'masculine' and an unusual choice for women was linked to a widespread lack of understanding of engineering in the UK:

If I say I work in engineering they [other people] imagine I wear a boiler suit and get greasy...so I think there is a combination of sides, let's say in terms of an overall misunderstanding of what the role is about and therefore with that a surprise that it's a topic that, why would I would work in engineering which doesn't have the same status as other professions in the UK?

For Angela, engineering was perceived as 'a mechanic type, dirty role' and maybe limited in scope, when in reality there is a broad range of roles that are not fully understood. During her time as an engineer, she had observed women entering engineering but then moving into areas such as HR or finance, which she felt was partly due to these areas being more acceptable for women and where they were more readily able to progress.

Dorothy felt that women were perhaps perceived as being less intelligent or technical than men. She saw this stereotype played out in the workplace, where she observed that while women tended to carry out most of the administrative tasks, men tended to deal with the ordering of parts and liaising with suppliers. She also felt that there was a perception that women under the age of thirty would go off and have children at some point, which meant they were not taken seriously by their manager. She explained the flexible working policy that was being rolled out in her organization but pointed out that in all her time at the organization, she had not seen a job advertised on a part-time basis. She believed part-time working was discouraged, which has implications for women returning to work after having children (Alvesson and Billing, 2009). Nancy described the perception of women in the industry in two categories: the first category being women who are perceived as being very feminine, cry or become upset quite easily and are quite fragile; the second category being women who are a little bit desensitised and probably act more like men.

Sandra began on a positive note, explaining that provided women perform in their jobs, they can progress and that an ultimate increase in numbers would help to change perceptions and increase the flow of women to the top. But she

also acknowledged that there was a perception that perhaps women needed to have certain masculine characteristics. In her own organization, there was an expectation that women should not show their emotions at work. Ruth did not believe there was a stereotype of women in the industry, dispelling what she described as, the 'blokey' Vs 'girly girls' perceptions, although she did acknowledge that people's perceptions were perhaps that to be an engineer, you had to be interested in cars or things perceived as being 'typically blokey'. As an engineer herself she simply wanted to be perceived as being good at her job and to take the 'woman factor' out of the equation.

Linda acknowledged that there were aspects to being in the industry that were unpleasant for women, citing wolf whistling on site and occasional aggressive behavior by men. This made her feel uncomfortable as a female. While she felt she could live with most of this, she found aggressive behavior a challenge and difficult to deal with. Cristina felt her organization was doing quite well in trying to dispel negative perceptions of women in the industry but that there was still a long way to go. This view had been confirmed when she was on secondment with an airline where she had experienced male behaviors similar to those cited by Linda. Angela described how some men had found it difficult to adapt their style to working with women and thus ended up feeling uncomfortable and trying to avoid working with them. While Donna had initially felt there were no negative perceptions about women, over time she started to change her mind. She felt that the negative perception lay with the older, male workers, near retirement age, who had grown up in a very different environment where there were no technical women.

Personal Challenges

Finally, we asked interviewees about any personal challenges they had experienced. Unsurprisingly, the majority had a number of these, including, being the only woman in the room; challenges around childcare, maternity leave and part-time working; having to 'prove yourself' as a woman; resistance from men to being managed by a woman; and general sexism.

Dorothy discussed the challenges and stigma attached to part-time working and how its acceptability depended upon the attitudes of line managers. She believed that her organization would abolish part-time working given the opportunity. She also raised the 'only woman' challenge in a technical team of men – all white and in their mid-fifties. She reflected on situations when her opinion was not taken into consideration as much as the more experienced males in the team and how this was exacerbated when she became the leader of the team itself.

Having to prove herself to gain acceptance, because she was a woman in engineering, had been an on-going challenge for Cristina. She described 'older people' having an 'old fashioned mentality' and being 'a bit sexist sometimes'. Not being able to join in the male conversations centering around cars and sport also made her feel excluded:

.... so I think because I was not interested in all the same topics as these guys were, so I think I had to prove myself as a good engineer even though I don't talk about cars all the time

Nancy had experienced sexism and offered the example of male colleagues not wanting to go away with her on business trips as they were nervous about going

away with a woman. She felt she had 'proved herself' and had steadily progressed, finding it easier to work with her male colleagues. For Paula, having to prove herself meant demonstrating she had performed as well as or better than her colleagues. In addition to undergoing the usual performance management reviews, based on objective criteria, she also felt that she was being assessed as a woman, believing the question 'when is she going to have children?' was at the back of the assessor's mind.

Cynthia's challenge was not being taken seriously because of her gender. A female colleague, who had been promoted the year before, had gone on maternity leave and she had heard a number of negative comments about this from her male colleagues. She felt that these male colleagues expected that she would also be going off on maternity leave soon and for that reason, were not regarding her as a serious candidate for promotion. More recently, upon turning up for a meeting in her role as head of engineering:

...I walked in and they said, could the head of engineering not make it then! I said, I am the head of engineering....because clearly you need to be engineering qualified to understand the details and they just assumed I was a business function leader with no practical experience

She believed this would not have happened had she been a man.

The main challenge for Linda was being 'treated in a derogatory way', as some comments she had experienced had been inappropriate and sexist. A previous manager, whom she described as having a problem working with women, had been a particular challenge. Despite trying to build a relationship with him over a

number of years, she finally gave up, which she felt finally negatively impacted on her career as he would not consider her for development or progression. Her replacement was a male 'hotshot' who was one of the boys and was evidently viewed as more credible to do the job. Jennifer revealed how she had to put up with inappropriate comments from male colleagues. Having studied and then worked in a male dominated environment, she had been exposed to what she described as 'certain inappropriate comments and attitudes' to which she learned to either respond, react, ignore or defend herself. While she did not feel she had been discriminated against, there had been moments when certain colleagues had behaved inappropriately.

Pamela had encountered men who did not like working for women, which she attributed to being younger, less experienced and female. She believed there were definitely some people who still thought or felt awkward answering to a female, particularly amongst the chief technical ranks with those who had been in the job a long time. She described it as 'very subtle' and something she could not always put her finger on, as it was more of a gut feeling. She had not experienced too much sexism until her second pregnancy, whereupon her male line manager's attitude towards her changed.

Discussion

Some key themes emerge which cut across the public and private sector divide, age groups and length of service/experience in the industry. There was a general awareness of the token status of women in the profession and its repercussions (Kanter, 1977) and while increased pressure over performance, social isolation

and role encapsulation have been widely discussed, in our study female engineers highlighted the relationship between this token status in the profession and the difficulties around attracting more young women. There was a feeling that if women were not merely 'tokens' and if there were more female role models, the profession would become much more attractive to young women. Tokenism was also linked to the part-time issue, with female engineers reflecting on the relation between part-time work and motherhood, either having seen other women with children who work part-time being treated differently by their line managers (or colleagues) and having had responsibilities taken away from them, or experiencing this first hand. This is also linked to some feeling that they have to make a choice between family and career, pointing out how part-time work has negative implications for women's careers (Durbin and Tomlinson, 2010; 2014). This links to the issue of organizations failing to encourage and genuinely value part-time and flexible working, despite previous research which has shown that part-time workers can be as committed as their full-time counterparts (Warren and Walters, 2002). Critically, unless social attitudes toward men's role in childcare, domestic chores and family life change, women who work part-time will continue to be at a disadvantage.

Our interviewees could cite many reasons why women are under-represented, ranging from the status of the engineering profession in the UK, early socialization of boys and girls (Bradley 2012), through to the 'masculine' image of the profession (Powell, 2006; Evetts, 2008). To this can be added having to 'prove yourself' as a woman, resistance from men to being managed by a woman and overt sexism. Poor schooling and a lack of careers guidance was another issue

highlighted by many interviewees, as was the male culture within engineering, making women feel like they are the 'other'. The physical aspects of the job do not appear to be a particular deterrent for women, apart from women in the military. Being accepted as a woman and having to prove yourself were recurrent themes.

Conclusions

Breaking down the barriers and in particular, making it easier for women to enter skilled occupations in higher paying male dominated industries/occupations is widely considered to be one of the ways forward for improving gender equality. It is recognized that we urgently need to increase the numbers of women in engineering/STEM based on the business case argument, linked to the idea that this will help to address the skills gap and improve productivity in the sector. But until the gender power relations in engineering organizations (Sharp *et al.* 2012) are tackled, women will remain the outsiders in this male world. Women are deterred from engineering due to its 'masculine' and 'dirty' image (Powell, 2006; Evetts, 2008) from a young age and many of those that do enter the sector change career or leave. This is worrying but perhaps these women can see the writing on the wall.

This begs the question, why do some women choose a career in a profession that has both a negative image (Institute of Engineering and Technology 2008) and is one of the most male-dominated professions in the UK? Our sample of women engineers has given us an insight into this. They decided they were going to fol-

low this career early on, enjoyed the challenges of the job and most were intending to stay. While they were not deterred by the negative masculine image of engineering, they were, however, experiencing challenges related to their gender and satisfaction with career progression was mixed. It is therefore unsurprising that women are being deterred from pursuing a career in engineering at several points of the 'leaky pipeline' (at school, upon graduating and upon becoming mothers). Could this change if the numbers of women increased? So far, efforts in this area have enjoyed limited success. We are not arguing that increasing the numbers would automatically lead to gender equality, however, we do believe it to be a step in the right direction.

Perhaps the presence of more women professionals in a better 'gender balanced' environment could lead to a more supportive culture, where women are assessed on their performance as engineers and not on their gender. This requires a greater change effort and flexibility from employing organizations, an increased self-reflection from men and greater help from those experienced women in engineering for the young women contemplating or just starting out in it (Durbin, 2015).

Understanding the educational backgrounds and employment experiences of those who choose a career in engineering offers some insights into why women do or do not choose this career path. It also helps to explain why there are so few women in engineering, where cultural and gender stereotypes are played out from the critical formative years, when very little help and support from teachers and careers advisers is available, through to the workplace where there are a myriad of challenges for female engineers. Change has to come and soon!