**Exploring Women’s Experiences of Choosing and Studying Engineering and Navigation: A case study**

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**ABSTRACT**

Women remain underrepresented in UK engineering, constituting only 11% of the engineering workforce in 2017 (WISE, 2017). This paper summarises the findings from two focus groups with twelve participants which explored the experiences of undergraduate women engineering and navigation students at the University of Plymouth. Our aim was to identify ways in which we might support the recruitment, retention and advancement of women in these disciplines. It was possible to identify common experiences to illustrate that women as a group experience engineering and navigation differently from men. Our findings support those of many other studies and include: the ‘non-visibility’ of engineering as a career option for girls and women and the need to adopt a range of strategies to fit in and claim an authentic identity as an engineer, and not a ‘woman engineer’. Additionally, participants were sceptical about initiatives overtly contrived towards helping women to progress in the disciplines as this can be perceived as positive discrimination towards male students and/or there is a concern that male students view them as such. Future research and possible initiatives are discussed.

**KEYWORDS**

Engineering; Navigation; gender; student experiences; under representation

**INTRODUCTION**

Engineering careers are potentially highly diverse, rewarding and desirable, yet, women remain underrepresented in UK engineering, constituting only 11% of the engineering workforce in 2017 (WISE, 2017). This is lower than all other European Union countries (UKRC’s analysis of the European Labour Force Survey, 2007*)*. This figure is even lower at under 5% for navigation and maritime science. These statistics show that in 40 years, efforts to improve the gender profile in engineering have had limited success. In navigation, efforts to increase female participation have only recently begun.

To be a woman Engineer therefore is to be a minority group member in a typically male dominated climate. There is extensive literature pointing to the adverse effects that this can elicit: well researched phenomenon such as ‘stereotype threat’ (Steele & Aronson, 1995), ‘imposter syndrome’ (Langford & Clance, 1993) and unconscious bias (Greenwald & Banaji, 1995) can all undermine performance, confidence and resilience of those who do not appear to ‘fit’ the normative ‘Engineer’ stereotype.

Whilst women remain underrepresented in Engineering at all levels, the recruitment, retention and progression of women undertaking Engineering degrees is critical for developing the pipeline of talent for the future.

The Equality Challenge Unit’s Equality in Higher Education: Students statistical report (2017) shows that 15.5% of students studying engineering and technology as their first degree were women.The report also shows that female undergraduates outperform their male counterparts in terms of good degrees with 79% of women achieving a first or 2:1 compared to 73% of men. So, whilst female students are underrepresented, they are actually performing better than their male counterparts.

Whilst this is encouraging for female students, it is still true that they often have to cope with a “chilly” environment (Flam, 1991), and feelings of non-belonging (Walton and Cohen, 2007), which can lead to negative wellbeing outcomes (Cohen, Garcia, Purdie-Vaughns, Apfel & Brzustoski, 2009). This potentially leads to a situation where women are succeeding but at a cost, perhaps offering further insight into why large numbers of women continue to be discouraged from pursuing an Engineering career.

A focus group methodology was employed to capture current female students’ experiences and attitudes towards engineering and gender. It was our hypothesis that gender would be an important shaping factor in the participant’s experiences of engineering in higher education and beyond.

**BACKGROUND**

There has been extensive research on the perceived reasons why women continue to be under-represented in engineering. In navigation, the research is in the early stages. There seems to be a genuine shift in employers and accreditation bodies in recent years to increase the female pool; supporting a number of initiatives in both fields. This section presents an in-depth literature review and the statistical data to support that.

**Under Representation of Women Students in Engineering and Navigation Disciplines**

Female under-representation in engineering has been well documented. Efforts to increase the percentage of women in engineering and STEM go back at least 40 years, with the inception of WISE in 1974. However, numerous subsequent initiatives both from the Royal Academy of Engineering (RAENG) society and other STEM activities have still failed to increase the percentage of females choosing engineering.

Some of the barriers highlighted in research are levels of achievement required in STEM subjects (Hulme & Wilde, 2015, p6) and the difficulty of transitioning between school to higher education (Wakeling & Hampde-Thompson, 2013). Other studies have found that women are attracted to STEM fields which they believe will allow them to help others and benefit society (Freund et al., 2012). Hence women are more likely to choose biomedical and environmental engineering than mechanical or electrical engineering (Ceci and Williams, 2011).

Women also put a higher priority on caring responsibilities and are willing to make occupational sacrifices for it (Hill et al, 2010, Eccles et al 1999 & Hakim, 2006). Traditionally engineering employers have shown less flexibility towards flexible working which has had an impact on retention of women in these fields. In addition, studies by Meyer et al (2015) suggest that in STEM subjects success is believed to require intelligence and talent against a cultural stereotype that women have lower mathematics ability (Bench et al, 2015, Luong and Knobloch-Westerwick 2017; Rea 2015; Shaffer, Marx, and Prislin 2013; Shapiro and Williams 2012; Thoman et al. 2008) which is again seen as a barrier for women to succeed in these fields. Despite a number of efforts to change the perception of engineering, it is still male-dominated (Lee, 2008; Chaudhuri, 2011; Thackeray, 2016), which is again seen as a barrier for females. Further, for women who choose engineering, classroom experiences can serve as a barrier at many levels towards career progression and retention. Women feel that they have to adapt themselves to a traditionally masculine culture (Baxter, 2010), work harder to prove their scientific authority (Smith et al, 2013), can feel demoralized in a competitive environment (Shedlosky-Shoemaker and Fautch, 2015) resulting in suffering from imposter syndrome characterized by “persistent thoughts of intellectual phoniness” (Hutchins & Rainbolt, 2016) and eventually change courses. A study by Ellis, Fosdick and Rasmussen (2016) suggests that after taking Calculus I women are 1.5 times more likely to switch to a non-STEM field compared to their male counterparts with the same level of preparation.

Experience of women in the Maritime industry is in early stages of research. The work reported by Mackenzie (2015) on the challenges faced by women in this sector, are exacerbated due to working off shore or on board ships. In addition, the female role models in this sector have compromised by not having a family or by becoming “one of the boys” to achieve high level positions. This is counterproductive, as it reinforces perceptions of the maritime industry as unsuitable for women. In the more recent work presented by Bhirugnath-Bhookun & Kitada (2017) male ex-seafarers who often occupy managerial positions are not used to working with women and can be overtly discriminating towards women. According to an article by Mukherjee (2017) there are seven main reasons why women are under-represented in the Maritime sector as (i) lack of awareness and information; (ii) male-dominated industry; (iii) lack of support; (iv) less acceptance by companies; (v) social, cultural and practical obstacles; (vi) lack of workshops and seminars and (vii) job security.

Interestingly, all of these apply to engineering as well despite of all the campaigns launched to challenge the under-representation of women in engineering. According to WISE (2017) girls make their choices based on the career opportunities that studying a STEM subject will offer. Therefore, to increase female recruitment in engineering it is vital that they are aware of the career opportunities as well as flexible working associated with engineering and navigation careers (IMO, 2018).

**Under Representation of Women in Engineering and Navigation Industries**

According to a recent report by UNESCO (2017) compared to 572 men, only 17 women have won a Nobel Prize in physics, chemistry or medicine since Marie Curie in 1903. In addition, the percentage of women researchers worldwide is only 28%. Despite a number of initiatives over the last ten years, women are less likely to enter and more likely to leave STEM careers (UNESCO, 2017).

In addition, the UK has the lowest percentage of female engineering professionals in Europe (only 6% registered engineers and technicians) as shown in Fig. 1. In navigation and maritime science, women in the UK account for just under 5%. Most European countries have similar female percentages in navigation and maritime science, except Sweden and Denmark where women make up 23% and 15% respectively (Zhao, 1998).



*Fig. 1 Percentage of female ‘Engineering Professionals’ in EU countries (UKRC’s analysis of the European Labour Force Survey, 2007)*

This data is even starker when navigation and maritime science is considered. According to a survey commissioned by International Seafarer’ Welfare Assistance Network (ISWAN, 2015) 60% of all women work on cargo vessels and 40% are employed within the cruise sector. Overall women only account for 2% of all seafarers.

Furthermore, the UK faces a skills shortage in engineering with universities recommended to double their intake of engineering students (RAENG & EPSRC, 2015). A recent report by IET (IET survey, 2015) found that only 6% of engineering companies offer flexible working and 57% do not have gender diversity initiatives. Furthermore research has also suggested that the retention rate of females in engineering compared to males is much lower - 25% as compared to 40%. Gender plays a much bigger part than social class in determining occupation types for females after graduation (Diversity in Engineering, 2014).

An earlier study conducted by Hodgkinson (2008) identified some of the barriers perceived as low visibility of engineering career and ’old fashioned’ employment expectations. A recent study conducted in Australia (Christie et al, 2017) found that it is the lack of information or mis-information that female students receive in their secondary schools as well as their own low self-esteem that plays a key role in not choosing STEM subjects. Their conclusion is simplistic, leading to a ‘deficit’ explanation (Glover, 2000), i.e. blaming girls for their ‘misguided’ choices. However, literature has suggested that it is more complicated than that.

Our focus group studies also revealed some of the issues covered in literature. While lack of information about what is engineering and navigation still persists, women engineers often experience the need to prove themselves. Positive action in engineering can be perceived by both men and women as positive discrimination creating more barriers rather than reducing them. Our study suggests that more effort is needed to ‘demystify’ the positive action taken by higher education institutes and accreditation bodies to address the gender imbalance in engineering and navigation.

**METHOD AND DATA COLLECTION PROCEDURE**

We conducted focus groups with female undergraduate engineering and navigation students to understand their choices and experiences. The advantage of the focus group method was that it facilitates interaction, allowing for the sharing of experiences and views. This can generate conversation and the raising of further topics and ideas that would not necessarily arise in a one-to-one interview for example (Bryman, 2012). In addition, analysis of focus group data can be grouped in similar themes, quotes can be captured and any unexpected findings can emerge (Breen, 2006). However, the limitations are the sample size, therefore, we should treat the results with caution.

The project received ethical approval from the Faculty Human Research Ethics Committee. Sixteen female students initially volunteered, with twelve eventually participating in the two focus groups. The first group comprised civil engineering students and the second was predominantly mechanical engineering students, but included one navigation student. All students were in their third year of study and some had completed an industrial placement year. The duration of the focus groups was approximately one and a half to two hours. Each focus group was co-ordinated by two facilitators and a scribe – two women and one man.

The focus groups were audio recorded and transcribed verbatim. All the participants were briefed and then asked to sign a consent form informing them that they can leave at any time during the process.

The topics of the focus group questions were focussed on why women had chosen their particular field of engineering or navigation and explored their experiences in the School of Engineering at the University of Plymouth.

**RESULTS**

The focus group data was analysed by transcribing the audio recordings and using a thematic approach. A number of themes emerged from the responses and these were grouped according to their relationship to i) choice of degree subject and ii) the experiences of studying it.

**Choice of degree subject**

The group interviews began by asking the participants what had led them to choose to study engineering (and in one case, navigation). It was possible to identify common themes that had constrained or enabled their choices. Barriers included the ‘invisibility’ of engineering as a study and career option for girls; a lack of positive encouragement to consider engineering; the belief that engineering is only for high achievers in mathematics and reactions from others confirming the view that engineering is not a conventional choice for girls.

***Awareness of engineering and navigation***

Many of the women said they had chosen engineering because they are good at science and maths and found it to be a discipline that combined these interests. However, the majority of participants agreed that engineering had not been presented to them as an option to aspire to whilst they were schoolgirls. Several of the participants mentioned that their choice for engineering was made at a very late stage in the university application cycle. In some cases, this was expressed as coming to engineering almost by accident and chance:

*I did maths and physics and kind of seemed to fall into it* (engineering) *as a lot of people did* (Civil engineering student)

*I saw a prospectus in the library in my new school and found engineering there. You don’t even know it* (engineering) *is a thing that exists!* (Mechanical engineering student)

For this reason, most participants agreed that more should be done in schools to raise awareness of engineering and the school subjects needed to access higher education study:

*Is it not the outreach of getting kids interested at that young age and make them aware of it? So that when they’re actually considering their A levels, or Uni degree they have that idea in their head of “oh yeah engineering is an option”, rather than a few of us* (girls) *last minute getting in?* (Mechanical engineering student).

Most participants felt that their schools and teachers had not actively influenced their choice for engineering:

*I don’t think it was ever dis-encouraged or encouraged. I suppose with some of the boys it was like: “oh are you going to be doing this”, but the girls it was never… they didn’t necessarily push you towards either, so they might encourage… with the girls it was like: “you choose” almost* (Civil Engineering student).

*The approach at school was rather than choosing what you want to do: “cross off what you don’t want to do”, rather than what you do want to do. And I was left with maths, physics, business and engineering. And engineering combines all of them* (Mechanical engineering student).

*I did maths and physics A level at school and… it’s a fair while since I’ve been at school, so but at that stage I don’t think they did engineering at my school. It was an all-girls grammar school. I don’t remember there being any talk about engineering at all really* (Civil engineering student).

Furthermore, in some cases, teachers and other advisers seemed to actively steer girls *away* from engineering:

*I did Design at A level and the boys from there went into engineering but it was never suggested for me and the other girl on the course. They kind of… yeah… pointed us more into graphic design and stuff like that instead* (Navigation student).

***The image of engineering***

Many participants agreed that most people are not sure what an engineer does, or there is a common misperception that an engineer is a car mechanic

**Participant 1**: *But no-one really understood what an engineer was either. So I still remember one of the girls like “oh what are you doing when you leave?” I was like: “Oh I’m going to uni, I’m going to study mechanical engineering” and she was like “so you’re going to fix cars and stuff?” I was like “not really”, I’m like: “I’m more likely to be designing them than fixing them, but sure, whatever! So they didn’t understand what I was doing at all.*

**Participant 2**: *I also had that. So in my gap year I worked on a golf club and I was saying I’m on a gap year and like ‘I’m doing mechanical engineering’ and they were like ‘oh you can go and fix my car, it’s just parked outside’ and I was like ‘no*!’

**Participant 3**: *I’ve had that as well*.

(Mechanical engineering students).

Conversely, some participants mentioned that engineering is perceived as a ‘difficult’ subject to get into – particularly because of the belief that you need to be a high achiever in mathematics:

**Participant 1:** *I think the teachers think it and I think the students think “if I’m not an absolute mathematics genius, I can’t study engineering” it’s already kind of put up there with like being a doctor you know, it’s like almost unattainable unless you’re in the top ten per cent of the school….*

**Participant 2**: *they do like to make it more like “oh it’s too complicated, you can’t do that” sort of thing…*

**Participant 3:** *Yeah, they put it on a pedestal, like I found like if I say to people “I’m doing engineering”, they’re like “oh really?!”, such shock. And it’s like “thanks”, but it’s do-able.*

***Encouragement by family***

However, several of the participants had relatives who were engineers or had some connection to engineering. In most of these cases, they had often been encouraged to consider engineering:

*I was going to university open day and I’d put down architecture ….like I was so ready to do architecture and we had to put down a second course and I was going with my dad and my dad was like “yeah, why don’t you put down mechanical engineering?” And I was just like “dad what is that, I’m not going to put that down”. And later on I found out that my dad actually did mechanical engineering as well. …. But anyway, he asked me to put it down and I did and we ended up going to the engineering talk first and I was fascinated!, it sounds cheesy but that is literally what it was* (Mechanical engineering student)

*…actually it was my mum. She said if she had her time again she’d go and be an engineer. And I found that… I was like: “well what is engineering then?” So yeah, looked into it and thought actually this could be quite interesting* (Mechanical Engineering student).

***An inauthentic choice for girls?***

Some of the women had faced reactions from others to their choice of A-levels or degrees, whether this was surprise, or bemusement. This served to remind them that their choice is atypical:

…*I* *was met with surprise when I picked maths and physics A level, doesn’t seem natural. In a way it’s nice, ‘cause people are impressed. But it shouldn’t be any different*” (Civil engineering student).

*I actually spoke to an actual civil engineer that came to the school to visit, you know, like careers. And he was speaking about it and he was like it’s rare for a girl to go into it, safety reasons and stuff like that. And I was like “woah, we’re not in the 1930s* (loud laughter from the group) *I’m sure we can cope” and he was “but that’s a very bold move” and I was like: “yeah”! I’m sure he didn’t mean it in a bad way, but it was just like…* (Civil engineering student)

**Experiences of studying the degree**

Generally, participants talked in positive terms about their study experience. Most participants agreed that they have equal status with men on their degree and that there is no difference in the way the sexes are treated. However, several themes emerged that portrayed a challenging learning environment for women students. Key amongst these was the belief that male students feel threatened by women on the course; the necessity for women to earn credibility, and the costs faced by women as a result of positive action measures.

***Confidence and competition***

There was a high level of agreement that male students tend to be more confident in their abilities than women students and that the men feel a need to demonstrate their superiority:

***Participant 1****: Some guys just think they are… some guys just think that because… I don’t even know what goes through their heads, but they just think that they know more than you do! Just because they are a…. and I don’t wanna say because they’re a guy, because there might be other reasons, but they are just like …and I could mention some names but I’m not going to…sorry yeah!*

***Participant 2****: Yeah they do, they think they’re more superior. And they, like I had a group … there was 7-8 of us in the design module and it was brutal for me. I absolutely hated it, and I just felt this big ….. I was like I’m good at design and you lot are just making it….it was hellish, it stripped all your confidence and it makes you feel like “I just don’t belong here - shall I choose something else?”*

***Participant 3:*** *I feel like guys are more resilient in that if you tell them … you know, if you point out a mistake they’ve done, for us you’d almost kick yourself for making the mistake where they just get on with it. But with the CFD module that we’ve just done - I’m so glad that’s over! But we’d have a couple - one in particular, not mentioning names… he’d ask for help and you don’t mind helping anyone and that’s fine and you’d explain your method and that’s fine…*

***Participant 4****: Depending on where you are compared to where he is in the coursework, he’s very different, like if you’re ahead of him in the coursework…..he’ll ask for help, but if he’s ahead of you, he’ll just mock you….*

(Mechanical Engineering students)

One participant had noticed increased competition in her final year that had resulted in a breakdown between herself and the male students in her study group:

*…in the last year I’ve noticed there’s a lot of egos going around …. stronger egos… and it’s hard work competing. It’s not about competition, but they make it like a competition, like: “I’m better, I know what the next step is”….”oh you just integrate that”. You always have to be a step ahead… and if you’re not a step ahead, you’re back down here. It’s got to the last year and it’s that massive pull between me and other guys* (Mechanical Engineering student)

***Proving yourself***

The fact that many male students appear to rate their abilities more highly than their female peers, intensifies the additional effort that women must make in order prove their right to be on the degree and in so doing, ‘earn’ their place. One participant, who is older than most of her peers, described her experience of working with her younger, all-male, group:

*One of the boys was talking to me but he didn’t think I could bring anything much to the party, but I brought a prototype and my design and he was like “well if you’ve done all that, let’s do that”. I did spend the rest of time organising them and they were perfectly happy to be organised. But then I’m older and they’re younger, so there’s probably that imbalance too and I’m maybe a bit more organised naturally* (Civil engineering student).

***Tolerating banter***

Robnett (2016) has described how women respond to gender discrimination perpretated by their male peers. Responses can range from active coping to passive coping. Whereas active coping might involve reporting an incident, passive coping involves accepting it, or denying that the behaviour constitutes discrimination. The passive coping response was reflected here in the idea that ‘banter’ must be tolerated:

***Participant 1****: the guys come out with stuff that I just know they’re just being sarcastic ‘cos they try to get a reaction out of me. They know… they’re starting to learn now that I just won’t bite … that prepares me for anything anyone else has got to say…… It is just pure banter. They treat everyone the same. They pick on each other ….They can say something about me being the only girl, but they’re not getting the reaction they want. Not had any serious discrimination.*

***Participant 2****…..I don’t think I’ve ever really had any negative comments. It is purely banter if anything. If they do get a rise out of me, they normally can take what they’re given and it’s a back and forth….*

***Participant 1****: I can understand how people (maybe who are new to the group) or hadn’t worked with these people before, they might be quite sensitive to this. Because I’ve worked with them before … lived with them, get used to it. There’s a girl who’s like: “are they being serious”? But if someone listened not knowing the people and you didn’t know what they were like, you could easily take offence (Civil engineering and navigation students).*

***Gender incongruity***

Other research has drawn attention to the way the presumed non-congruence of engineering and femininity operates to exclude women (Faulkner, 2006; Phipps, 2007). Some of the participants’ comments indicated that norms of ‘appropriate’ femininity for women engineers are in operation. For example, being a ‘Tomboy’ is one form of ‘acceptable’ femininity for engineers:

*I was always a bit of a Tomboy … I did always get on better with guys … they can be straightforward and a bit more objective* (Mechanical Engineering student).

Conversely, in another part of the conversation, the implication was that certain types of femininity went against convention:

* ***Participant 1****: I think that your interests that led you to choose it* (engineering) *tend to all be male-dominated interests anyway, whether academic or not. For most of my life I’ve had mainly male friends, male interests, male hobbies…..*
* ***Participant 2****: I disagree … ‘cos for me, I’m like the most girly girl out there, but I’m still interested in engineering, so I don’t think it’s set that your hobbies have to be like this ….*
* ***Participant 3****: I’ve never met anyone like you though* (laughter) ….*in apprenticeships and the college and stuff, all the girls are like… hoodies, chilled out. Whereas when we had a conversation the other day you were prim and proper - you were like: “I don’t know what to wear tonight”.*
* ***Participant 4****: We were like: “just wear what we’re wearing – but you were like: “no I can’t do that”.*
* ***Participant 2****: Yeah that’s what I mean, so I’m not, I dunno… I’ve never been a tomboy. I grew up playing with dolls hair and cooking and whatever. I dunno… I just think there can be both like I don’t think it’s one or the other.*
* ***Participant 5****: You’re the exception basically* (laughter)

(Mechanical engineering students)

***Positive action backlash****:*

On the question of tackling gender imbalances in engineering, most participants supported the idea of actively encouraging schoolgirls to consider choosing ‘non-traditional’ subjects for A-level and beyond. However, many agreed that once they have reached the university stage, women have equality with men, or sometimes even an added advantage, therefore, extra support is not needed:

*Is it not more about getting people into university in the first place? I feel like … when you’re at university, there’s nothing you can really do at that level for the students that are currently there, unless you’re going to be discriminating the women and giving them extra support when they don’t… like … we’re equal. Like you were saying - with the Olympics you’ve got different genders because of the different capabilities but in engineering we’re all together because we have the same capabilities* (Mechanical engineering student).

*I think the outreach is a good thing, with being the STEM ambassadors, potentially going out to schools and encourage girls in to engineering, I think that’s good…..I think we all expect to have to measure up …..I know they might look at your CV twice, but you’d like to hope that you’ve got to be as good as the male applicant to get the job …. I don’t think any of us would want to be handed it on a plate would we?* (Civil engineering student).

Two of the participants had been active in starting a local university branch of the Women’s Engineering Society (WES). However, several participants said they don’t believe in ‘women’s initiatives’ such as WES. Others expressed ambivalence about joining. The majority of participants believed that actions to support women studying engineering are unfair. Several mentioned that WES is perceived as a threat by their male peers (even though men can join). Many share the view held by their male peers - that actions to support women in engineering are a form of positive discrimination:

*To be fair …and I just want to play devil’s advocate - if I was a bloke … or, say it was the other way round and I was a woman … and I go into the societies hall and there’s a men’s engineering society and they’re like: “well you can join if you want, you are a woman, but it’s called the Men’s Engineering Society”. I’d be like: “they’re not allowed to do that!* (Mechanical Engineering student).

A widely held view was that women’s ‘unfair advantage’ is particularly visible when students are being selected for industrial placement and graduate jobs:

***Participant 1****: When you reach the stage of going … I mean, at our age when you’re starting to go to university….*

***Participant 2****: Once you’re here, how are we being looked after? It’s pretty good.*

***Participant 1****: I feel like fairly like we’re seen as equal. If you’re trying to put more effort into support for women, it’s kind of like…what you were saying, it’s kind of….*

***Facilitator****: counterproductive?*

***Participant 1****: Yeah. And it’s kind of making the guys feel a bit like shit to be honest… like: “why are they getting extra support and I don’t when they’re more likely to get a job afterwards”?*

***Participant 3****: They see us as competition as well… like “she’s gonna get the job, I’m not”. And I hear that quite a lot. And there’s a couple of guys that are applying for the same jobs as I am. I failed the psychometric tests, but they haven’t, but they were like: “yeah but if it was an interview, you would have got it”. And it’s like, it’s not very nice to say that, at all. Like hopefully they’ll go by my CV, but …….they look at us as a threat towards their future and…*

***Participant 2****: We are!*

(Mechanical engineering students).

*When I speak to the Careers Advisers, they tell me: “we shouldn’t really tell you this, but we’ve had a couple of companies and we’ve told them they’re not allowed to say this - say they only want women. They say ‘we’re going to advertise it to men as well’ but they’re only looking for female engineers”. And it’s not fair*! (Mechanical Engineering student).

In addition some participants mentioned that the WES group is assumed to be women-only and, by extension, ‘anti-men’:

***Participant 1****: That hurts, to be honest, they’re seeing ‘women in engineering’ as: “I hate men” - no-one said that.*

***Participant 2****: That’s the problem that we see at work. People just hear “Women in Engineering” and they’re…..*

***Participant 1****: …..just like… “I hate men”. Nobody said that!*

(Mechanical engineering students).

***The desire to be accepted as an ‘authentic’ engineer***

For many participants it seems that initiatives such as WES are perceived to be at odds with the need to fit in and be the same as everybody else. The desire to be accepted simply as an engineer, not a ‘woman engineer’, was expressed frequently, as is the need to get the placement/job on merit:

*you’re like… “I don’t want to be looked at because I’m a woman in engineering, I just want to be looked at as an engineer”. So it’s definitely something you get a lot of…..“Oh you’ll be fine, you’re a woman”. You’re like “OK*” (Civil engineering student).

*What I want is for them to just not see me as a woman. I want them just to see me as an engineer. And I think the problem with putting all these unfair advantages on women … I know why they want to do it, but it’s creating a barrier between us and our fellow engineers …..but, all they hear about now is “Women in Engineering” and I try and put myself in those shoes. And I feel sorry* (Mechanical engineering student).

Even though there was a consensus amongst participants that they want to be accepted as engineers, not as *women engineers*, as Faulkner (2006) points out, women can be sexually visible in a way that the men are not. This can be costly to women engineers. For example, one participant talked about the breakdown of her relationship with her male groupwork colleagues. This was attributed to their female partners, who assumed that she was heterosexual and posed a threat to their relationships:

*I’ve lost a lot of friends…mainly one guy…his wife thought that me and him were having an affair. Sorry, but I’m a lesbian, like …..like.. how is that even on the cards right now?…I’m here for the same reason as you are! And that’s when I had to pull away from all seven of them …I can’t be a part of that! There’s another person in that group who says his girlfriend says I’m not allowed to message him about coursework outside 9 to 5* (Mechanical engineering student).

**DISCUSSION**

Our findings show that the women who choose engineering are aware that they will be in a minority and that will shape their experiences. Our participants felt that they had to prove themselves academically to their male counterparts. This is supported by Blackburn (2017), who highlights in the USA that while progress is made, the reports of the lived experiences of students reveal stereotypes, biases, chilly campus cultures, unsteady identities, and a wavering sense of belonging that are still barriers for successful degree completion and career entry.

In addition, the need for career/life balance is possibly a bigger consideration for women as more women in civil engineering preferred to be consultants instead of contractors. They have considered how being on site can affect caring responsibilities. There was a strong desire from our participants to be recognised as ‘engineers’ and not ‘woman engineers’.

In navigation, being on a cruise ship is a preferred career option for a woman as it allows for a better work/life balance and more acceptance from male colleagues compared to a cargo ship. Some shipping companies around the world see women as a distraction to the crew. This is supported by a recent article written by Nadkarni (2017) that there is a greater focus on women’s appearances compared to their male colleagues attracting both sexualised attention and criticism on their appearance.

A study conducted in the USA by Wang et al (2016) concluded that women’s under-representation in STEM is due to cultural barriers, gender stereotypes or lack of information. A recent survey of 558 women conducted by Northfield (2018), initiated by the Institution of Mechanical Engineers, 63% of the participants said they experienced unacceptable behaviour or comments in the engineering sector which is three times more likely than the financial or medical sector. Further, nearly 40% of the women surveyed felt that they were not treated equally by managers, people they manage or peers. These survey findings are shocking. Our findings support those of other studies and show that women are not under-represented simply because they lack information, or make ‘misguided’ choices.

Many of these issues have been reported earlier, however, they still persist in engineering. In navigation, it is only recently that the masculine culture is being reported. There is also a miscommunication regarding engineering at schools and beyond. For example, more than one of our participants said that she still ‘wasn’t sure what an engineer does’. Engineering is a diverse field that makes a positive difference in society, however, despite of all the efforts to date, schools are still not well-equipped to inform about engineering. In a recent survey conducted by Wilson (2018), 60% of girls aged 11-14 think that they can become engineers compared to 72% of boys. This figure drops to 53% among the 16-19 year olds where only a quarter of girls say that they would consider engineering as a career.

Navigation suffers a similar fate. While it is necessary to increase the awareness about engineering and navigation not only at secondary schools, but start early at primary schools, it is important to not assume that will fix the gender under-representation. Our studies have shown that for those women who have chosen engineering, for them to practice as engineers, employers need to be more inclusive and the ‘laddish’ culture should be challenged.

Overall, the strength of these focus groups was to garner detailed description from current women students about their experiences of engineering and navigation disciplines. Their reflections often aligned with issues of gender and progression identified in the research literature, such as the non-congruence of engineering and ‘femininity’. Participants also expressed a preference to distance themselves from positive action overtly contrived to support women only; they preferred to see themselves – and to be seen and treated as – equal to men. Women only initiatives can be perceived as discriminatory, potentially making women feel vulnerable to criticism and men indignant and resentful. This is a notable paradox for academics, employers and equality practitioners seeking to promote gender equality: on the one hand gender remains an important factor in shaping the student experience, and on the other, actions to equalise opportunities can elicit negative reactions from men and women.

**CONCLUSION AND RECOMMENDATIONS**

Our findings show that a long history of outreach and support initiatives has had limited impact in increasing female participation and progression in engineering. Schools are not necessarily giving girls the opportunity to find out about engineering and navigation options.  Those women who *do* become engineering students feel the need to gain credibility and make compromises in order to ‘fit in’.   Positive action initiatives and support networks have had limited impact in tackling the underlying gendered culture of the disciplines. Furthermore, women are discouraged from participating in ‘women’s initiatives’, because they are seen to give them an unfair advantage, or imply that women need extra help. The perception that such initiatives are discriminatory or ‘anti-men’ leaves women no basis on which to act collectively, or even in partnership with men. However, without positive action, nothing changes.

We must further explore students’ perspectives in order to find a way forward.  In our future work, we will be conducting male-only focus groups in addition to female-only focus groups. We will also be piloting an equality, diversity and inclusion committee for undergraduates encouraging equal male female representation.

Equality initiatives of the future must be sensitive to the unintended consequences noted here. One avenue for further exploration is to articulate a role for men in promoting gender equality. Men need to be included in promoting equal opportunities and both men and women need to be aware of why it is still necessary to take positive action to bring more women into the Engineering and navigation professions.

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