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DESIGNED FUTURES

Design educators interrogating the future of design knowledge, research and education.

'The Pretty Stuff': Gender bias and the future of design knowledge in the South African industrial design context

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Abstract

In the era of the fourth industrial revolution that proposes an increasingly automated future, designers need not lose focus on the discipline's important role in social design and innovation. Such an undertaking becomes difficult when the discipline of design itself has inbuilt biases and inequalities. Gender bias is one such prejudice that design educators and researchers need to become more aware of and engage with, not only to prepare our students for the workplace but also to begin to change the patriarchal dominance of the design industry and hence the equity of the discipline itself.

Current issues of gender disparity in design industries and academia have been studied and clearly articulated in the Global North. For example, in a recent study by the British Design Council, the United Kingdom's (UK) design workforce comprised of a 78:22 gender split (male to female), with Industrial Design showing the greatest disparity with a 95:5 gender split (Design Council 2018). In comparison to the 53:47 gender split of the wider UK workforce, this inequity is alarming, especially considering that 63% of all UK Art and Design graduates are female (Design Council 2018). Furthermore, various studies report a significant lack of female role models in leadership positions. This raises the question, 'Where have all the women gone?'

One of the authors is a young female academic, who, during South Africa's Women's Month in 2018, was inspired by these global statistics to conduct a small-scale study within a South African academic institution to investigate and reflect on the participation and experiences of female graduates in the local Industrial Design industry. Gender-based data of departmental enrolment and throughput over the past 20 years were analysed, and 10 female Industrial Design graduates were interviewed regarding their experiences in industry. Findings indicated significant gender biases and inequity within the local Industrial Design discipline, echoing global statistics.

Female student enrolment has increased from 9% in 1997 to 36% in 2018. The exit-level graduate gender split has evened out from 97:3 in 1997 to 55:45 (male to female) in 2017. This indicates that more and more women are slowly entering industry. However, feedback from

women in industry highlighted sexual harassment, misogyny, condescension and significant pay gaps as some of the many challenges faced when entering the long-established patriarchal Industrial Design industry. Stereotypical expectations of women's role in creating 'the pretty stuff' hinders their ability to access experiential knowledge. This stunts their growth in the field, resulting in many women leaving the 'boy's club' and pursuing opportunities in more female-dominated disciplines; ultimately perpetuating the patriarchy of Industrial Design.

It is therefore important to invest in gender diversity in design academia and to understand, engage with and tackle such issues locally. This includes preparing our students for the current realities of industry and empowering them with the necessary knowledge and skills to implement change by fostering innovation, and ultimately enabling them to break out of the confines of a long-established patriarchal industry.

Keywords: Design knowledge, local vs global, gender bias, 4IR, innovation, diversity

Introduction

Industrial Design is defined as "a strategic problem-solving process that drives innovation, builds business success, and leads to a better quality of life through innovative products, systems, services, and experiences" (World Design Organization 2016). As we enter the fourth industrial revolution amid complex economic, social, political and environmental upheavals, Industrial Design, at the nexus of engineering and the humanities, has an important role to play in bringing about sustainable change (Loy & Novak 2019). "Good design puts people first" (Design Council 2018, p. 4), and as evidenced by many human-centred design methodologies (van der Bijl-Brouwer & Dorst 2017), for change to be appropriate, diverse voices need to be heard. The participation of women, with their own tacit knowledge, in the design process is, therefore, vital to arrive at suitably diverse, appropriate and innovative outcomes (Barnhart & Walters 2018b). There is no better way to do this than for the design discipline itself to be diverse. Race and ethnicity aside, Industrial Design is noted for its absence of practising women designers with "low levels of female participation, retention and long-term success in the profession (Bruce 1985; Lockhart 2016). For decades, other male-dominated disciplines such as Architecture and Engineering have acknowledged, formally documented, discussed and actively attempted to transform the underrepresentation of women in their industries. However, in Industrial Design, even the first step of documentation has not been rigorously undertaken with limited statistical data on women in the profession (Barnhart & Walters 2018a 2018b). While data regarding the participation and retention of women in Industrial Design are 'patchy and difficult to obtain' in the Global North (Lockhart 2016, p. 11), in the Global South and South Africa in particular, this data is non-existent. This paper, therefore, attempts to engage with this gap and focuses on the issues of gender disparity in the discipline of Industrial Design within both the educational and professional contexts in South Africa.

Contextualisation

The fourth industrial revolution presents a global transformation in all aspects of business and production. Higher education has an indispensable role to play in facilitating the educational and societal transitions necessary to adjust to Industry 4.0 (Gleason 2018, p. 5). To participate and compete in the fast-changing industry, leaders of Industry 4.0 will need to be critical thinkers, problem solvers and innovators. South Africa is one of the few countries in a technological recession, facing a significant skills shortage in the areas of technology and innovation (Merrington 2017). Innovation is not reliant on new technology alone, but rather, requires a fusion of technology and creative thinking through design (Land 2013). "With increased shifts away from an economy premised on labour and resource-intensive industries

towards a knowledge economy, the skill sets and capabilities needed [for Industry 4.0] have shifted" (Rodny-Gumede 2019). Therefore, the success of South African higher education in this new era will be dependent on its ability to cultivate innovation through fostering transferable, divergent skills and capabilities, such as critical thinking, collaboration, communication and creativity (Rodny-Gumede 2019). Where traditional Science, Technology, Engineering and Mathematics (STEM) degrees focus on convergent skills/thinking, Art and Design degrees focus on the divergent skills necessary to remain competitive in Industry 4.0 (Land 2013). Therefore, design and design knowledge are at the heart of the fourth industrial revolution as both a resource for and a form of innovation (Design Council 2018).

"Designers have the ability to shape the built environment, the digital world and the products and services we use" (Design Council 2018). Not only will future design professionals need to be trained in emerging technologies, but also, in the human values associated with using such technologies. "For those educating the next generation of designers, the challenge will be to find the balance between teaching traditional foundational design skills and the new, emerging elements and technologies needed to prepare students for the changing world" (Lockhart & Miller 2015a; Lockhart 2016, p. 93). Such a focus will not only be on technology, but also the greater need for the understanding of human interaction (Lockhart & Miller 2015a).

Underpinning all of the considerations of higher education in Industry 4.0 are issues surrounding gender (Gleason 2018). "Economists predict that by closing the gender gap in both representation and pay gap by just 10%, South Africa could achieve higher economic growth" (Chauke 2018). However, Industry 4.0 will impact women and men differently (Gleason 2018). The current underrepresentation of women in STEM fields around the world, suggests that women are less likely to have digital literacy, and will thereby be less likely to take advantage of technological opportunities (Blickenstaff 2005; Gleason 2018). While it is widely understood that women are significantly underrepresented in STEM disciplines, little research exploring the participation, experience and success of women in design exists (Lockhart 2016, p. 2). Do women in design have equal opportunities to participate and succeed in Industry 4.0 as men? Some believe that Industry 4.0 serves as an opportunity to bridge the gender gap (Chauke 2018). In the First Industrial Revolution, workers with physical strength and quick acquisition of skills replaced artisans previously valued for their ingenuity and creativity. Today, those workers are being replaced by machines capable of handling repetitive tasks and heavy lifting in factories. Industry 4.0 will, therefore, put emphasis and value back on the human elements of ingenuity, creativity and innovation, not only traditionally masculine skillsets (Funna 2018).

Historically, men and women have been sorted into different types of design employment through gender socialisation (the social and cultural characteristics traditionally expected from women and men) and stereotypical demarcations of gender boundaries. Women are overrepresented in the 'soft' design areas of Interior, Fashion and Textiles, and Jewellery Design and underrepresented in the 'hard' design areas of Industrial, Digital and Architecture (Clegg & Mayfield 1999; Lockhart & Miller 2015a; Lockhart 2016; Reimer 2016). Academically, "there is a paucity of research explicitly exploring the participation, retention and success of women in design industries" (Lockhart 2016). However, the issue of gender disparity in design is gaining traction in the Global North.

Research indicates that the United Kingdom's (UK) design industry is distinctively white and male-dominated (Design Council 2018; Reimer 2016). A recent study by the British Design Council has provided significant insight into the issue of gender disparity in the UK design industry. *The Design Economy 2018 Report* (Design Council 2018) revealed that the UK design workforce comprised of a 78:22 (male to female) gender split, compared to the 53:47 gender split of the wider UK workforce. This inequity is especially alarming, considering that 63% of

all UK Art and Design students/graduates are female (Design Council 2018). The disciplines of Multimedia, Architecture and Industrial Design showed the most significant gender imbalances (Table 1), with Industrial Design showing the greatest disparity with women comprising of only 5% of the Industrial Design workforce (Design Council 2018). According to McMahon and Kieran (2017), the disciplines of Architecture and Graphic Design appear to be closing the gender gap. However, female industrial designers remain significantly underrepresented in both professional and student realms in the UK.

Table 1. UK Design occupations by gender in 2016 (Design Council 2018, p. 52)

Design subsector	Male (total)	Male (percentage)	Female (total)	Female (percentage)	Total
Architecture and built environment	273,300	80.0%	68,200	20.0%	341,500
Design (multidisciplinary)	31,700	36.3%	55,600	63.7%	87,300
Design (advertising)	22,900	62.7%	13,600	37.3%	36,500
Design (craft)	82,000	77.4%	23,900	22.6%	105,900
Design (digital)	411,900	85.1%	72,400	14.9%	484,300
Design (clothing)	3,800	27.5%	10,000	72.5%	13,800
Design (graphic)	78,100	64.4%	43,200	35.6%	121,300
Design (product and industrial)	148,900	94.7%	8,300	5.3%	157,200
Design economy	1,052,400	78.1%	295,200	21.9%	1,347,700

In 1990, women comprised only 15% of Australian Universities' Industrial Design graduates (Lockhart 2016). By 2010, women made up approximately 50% of the student cohort (Lockhart 2016). Although the gender mix of the student population in Industrial Design courses in Australia has shown a notable increase in female graduates over the past 20 years, according to Lockhart (2016), and concurring with the findings of the UK Design Council's report, the same change does not reflect in the profession, with women remaining 'seriously underrepresented' and even 'invisible' as practising industrial designers in Australia. Similarly, Industrial Design schools in the United States of America (USA) have equal ratios of male to female students, but professional practice is merely 19% female (Barnhart & Walters 2018b).

The 'leaky pipeline' metaphor, commonly used with regards to STEM disciplines, attributes the lack of female representation in industry to the 'leaking' out of women from the pipeline carrying students from school through university and on to industry (Blickenstaff 2005). It is evident that there exists a leaky pipeline in the Design disciplines, especially the field of Industrial Design. As with most STEM disciplines, the absence of women in Industrial Design appears to be progressive, in other words, "the farther along the pipeline, the fewer women you find" (Blickenstaff 2005). According to Blickenstaff (2005), *various* complex factors act as 'layers' in a gender-based filter that removes women from the pipeline as opposed to any single primary cause (Blickenstaff 2005). Examples of these filters include "a lack of mentors, a lack of female role models, gender bias and unequal growth opportunities compared to men" (Gleason 2018). Back in 1990, Bruce and Lewis described three hurdles that women face in design, first, the completion of a Design degree, second, getting a job and third, obtaining success in industry. These hurdles continue to be relevant today and form the bases of our study's exploration.

Methodology

To understand the leaky pipeline phenomenon in Industrial Design, we explored female participation and experiences at each of Bruce and Lewis' hurdles (1990). It was, therefore, important to explore both professional and educational contexts.

In terms of the professional context, during South Africa's Women's Month in 2018, one of the authors conducted a small-scale study within a South African academic institution to investigate and reflect on the experiences of female graduates on their Industrial Design education and their roles and participation in Industrial Design industry. Due to the Industrial Design profession in South Africa is relatively fluid, there was a lack of up-to-date contact details of graduates. Therefore, an open invitation to participate was placed on the institution's Department of Industrial Design Facebook group, which consisted of almost 1000 members, including past alumni, current students and other interested parties. Additionally, LinkedIn was used to approach known female graduates through the networks of academics who had been working at the department for a significant amount of time. Email-based interviews were conducted with 10 women who had graduated from the Industrial Design course within the last 15 years. Participants varied in age, race and work experience. Each participant was asked to provide feedback/insight into their experiences as a practising female industrial designer. All participants were informed that their identities would remain anonymous, this anonymity also enabled open and honest explorations of their experiences. It is interesting to note that the female author that undertook the study has a name that recently is more common for men, this resulted in some of the more critical female graduates immediately highlighting the irony of what they thought to be a male undertaking such research!

In terms of the educational context, we investigated the demographics and culture of the education system that designers (male and female) have come from. There is no published gender-related data on South African design students, we, therefore, used data from the same South African educational institution with particular focus on the design faculty and gender-based enrolment and throughput.

In the findings below, the authors not only unpack the study, but also contextualise and discuss the findings with regards to South African statistics found in other cognate disciplines, as well as within broader global statistics and experiences, as a means of better understanding the local and global extent of gender bias in design, and in particular Industrial Design.

Findings and discussion – Industry

A UK Women in Architecture survey indicated 73% of respondents (from 500) claimed to have experienced or witnessed gendered discrimination during their career, with 10% reporting that they directly suffer from gendered discrimination weekly (Waite & Corvin, cited in Lockhart 2016, p. 28). Findings from our study indicated significant gender biases and inequity within the local Industrial Design discipline, echoing global statistics. Most participants acknowledged sexual harassment, misogyny and condescension from employers and colleagues as some of the many challenges faced when entering the long-established patriarchal South African Industrial Design industry. Such patriarchy is found in many cognate industries in South Africa, with the World Economic Forum, stating that South African women are under-represented at a ratio of 3:10 in Engineering, Manufacturing and Construction (Chauke 2018). This reality played out in many of the first-hand experiences of those that were interviewed:

My first few months, as the only female at this small design consultancy, saw me dealing with misogyny, harassment and a general condescending attitude – especially when it came to the technical aspect of manufacture (P5 2018).

Many participants echoed experiences that it was not only their employers that were problematic in their bias, but that,

[C]lients, suppliers and manufacturers won't look you in the eye or shake your hand. You'll often get asked to make coffee for meetings and have to listen to offensive, sexist jokes (P3 2018).

[C]lients would put far more faith and trust into a male colleague's opinion and skills than [the participant's] own. This lack of trust in me and my skills gave me confidence as a designer and maker quite a knock (P1 2018).

As a result of these stereotypical expectations of women's abilities, some women only receive the types of work that offer little creativity and responsibility, resulting in reduced opportunity for advancement (Lockhart 2016). Examples of this include the following statements:

We are not always trusted with technical projects, and we are often given projects at the end to be prettified (P2 2018).

I was generally confined to drawing pretty concept drawings (P5 2018).

According to the mind-set of our industry, we are women, so we make things look pretty while the men are physical and create things (P7 2018).

This hinders women's ability to access experiential knowledge, and by losing out on learning opportunities, this stunts their growth in the field, and engagement/interest in the discipline, as described by one of the participants:

I felt very much obliged just to put up with it for the sake of gaining experience – but really, I was excluded from most learning opportunities (P5 2018).

A few of the participants had subsequently left the profession in favour of more gender-equitable industries such as Interior Design, Graphic Design and Advertising. Two participants explained that,

[T]he advertising industry is a lot more receptive to a female's opinion, perhaps because there are so many females in that industry (P1 2018).

I possibly feel more comfortable here because most of my colleagues are women, and we can relate to each other more easily (P6 2018).

This may be true in the lower levels of employment, but it is common knowledge in the South African context that there is also a 'glass ceiling' in these industries regarding women getting into senior management positions. According to Lockhart (2016, p. 137), "the glass ceiling is quite low in Industrial Design". In a UK survey of female industrial designers, it was observed that if they did not see other women in the field, particularly in positions of leadership, confidence in females began to erode and opportunities to progress in their career were not exploited (Kieran & McMahon 2017).

Furthermore, several female UK industrial designers interviewed related experiences of inappropriate behaviours towards them and a pervasive 'lads' culture that made for an uncomfortable working atmosphere (Kieran & McMahon 2017). To escape such discomfort, one of the participants in our study, after working in industry for eight years, was currently studying to move out of the field stating, "studying Industrial Design and coming into this field has been my biggest regret!" (P2 2018). Unfortunately, women leaving the 'boys' club' and

pursuing opportunities in more female-dominated disciplines ultimately perpetuates the patriarchy of Industrial Design.

There were, a few positive comments from participants who just "ignor[ed] the nonsense" and let their work speak for itself:

In my experience, it doesn't matter if you're male or female, your work speaks for itself (P7 2018).

I don't really acknowledge it, because if you don't treat it as an issue, it generally doesn't become one (P8 2018).

A similar study to the one we undertook was conducted at an Australian university in 2016 (Lockhart 2016) and showed very similar results. Most respondents found the Australian Industrial Design industry to be male-dominated and reported that they "struggled to develop the confidence and courage to actively contribute design ideas" (Lockhart 2016). 52% of female industrial designers interviewed described experiencing gender-based issues and stereotypes in the workplace, including sexism, male gatekeeping and stereotypical perceptions of their skills and abilities (Lockhart 2016, p. 137). According to Lockhart (2016, p. 141), "gender-based patterns appear to be accepted as just something that women must deal with", and to achieve success in the industry women must "adopt male-attributed traits such as toughness and competitiveness".

In response to these realities, coupled with a dissatisfaction with the types of work, levels of creativity, and lacking work-life balance, 42% of the Australian participants had decided to embrace their own abilities by creating their own businesses (Lockhart 2016, p. 161). These women described how mentors were critical in entrepreneurship (Lockhart 2016). One participant from our study also decided to become a design entrepreneur, where she was currently developing children's furniture and other homeware. Similarly to the Australian study, she felt she was able to take this leap since there was an "incredible community of women entrepreneurs who support and uplift each other" (P1 2018). A key benefit to starting your own business as a woman is that instead of having to try to change or conform to the existing industry, you make it your own.

Findings and discussion – Education

The above findings suggest that the two 'hurdles' of entering and succeeding in industry still stand for female industrial designers (and other cognate disciplines) globally. To understand why this gender disparity and culture exists in industry better and why this male dominance is still so prevalent, one must begin by considering the first 'hurdle', obtaining a design qualification (Bruce & Lewis 1990).

The faculty that was studied comprised of eight departments, namely Fashion, Jewellery, Interior, Architecture, Industrial, Graphics, Multimedia/UX and Visual Art (as this study focuses on design disciplines, data related to Visual Art is not included). Over the past 10 years, women account for over 50% of the student cohort. In 2018, women represented 51%. However, there is an uneven distribution of gender within the various disciplines. Table 2 shows an overview of the gender split in the student cohort (across all year groups) in each department over the last 10 years. The Departments of Graphic, Interior and Fashion Design have remained female-dominated, although more recently tending towards an 'evening out'.

Table 2. Overview of departmental gender profiles of total student numbers from 2009 to 2018

Department	Industrial		Graphic		Multimedia		Interior		Jewellery		Architecture		Fashion	
	F	M	F	M	F	M	F	M	F	M	F	M	F	M
2009	19%	81%	66%	34%	34%	66%	84%	16%	69%	31%	33%	67%	89%	11%
2010	23%	77%	64%	36%	36%	64%	78%	22%	67%	33%	35%	65%	90%	10%
2011	19%	81%	65%	35%	34%	66%	75%	25%	65%	35%	35%	65%	90%	10%
2012	23%	77%	65%	35%	36%	64%	76%	24%	69%	31%	33%	67%	92%	8%
2013	28%	72%	65%	35%	38%	62%	77%	23%	65%	35%	31%	69%	89%	11%
2014	38%	62%	70%	30%	36%	64%	75%	25%	65%	35%	34%	66%	88%	12%
2015	40%	60%	68%	32%	33%	67%	71%	29%	59%	41%	35%	65%	88%	12%
2016	36%	64%	66%	34%	30%	70%	72%	28%	42%	58%	39%	61%	87%	13%
2017	37%	63%	62%	38%	31%	69%	74%	26%	42%	58%	37%	63%	85%	15%
2018	39%	61%	61%	39%	34%	66%	75%	25%	33%	67%	38%	62%	85%	15%

Table 2's data aligns with the stereotypical overrepresentation of women in these 'soft' design disciplines. The Departments of Industrial Design, Multimedia and Architecture are clearly male-dominated. However, only Industrial Design has shown a significant shift in gender equality over the past 10 years (from 19:81 in 2009 to 39:61 in 2018). Interestingly, the Department of Jewellery design has shown the most significant change, flipping from a 2:1 female dominance in 2009 to the opposite in 2018. This dramatic change is most likely attributable to the statistical influence of relatively small student cohorts.

Focusing specifically on Industrial Design over a longer 20-year period, female first-year student enrolment has increased from 9% in 1997 to 36% in 2018 (Figure 1). The number of female exit-level graduates has evened out from 3% in 1997 to 45% in 2017. The greater numbers of female graduates indicate that more and more women are slowly entering industry over time. These figures, to some extent, also explain the patriarchy of the industry with a history of far more men than women entering industry. Past graduates worked for men and with men. These men are now well-established in industry.

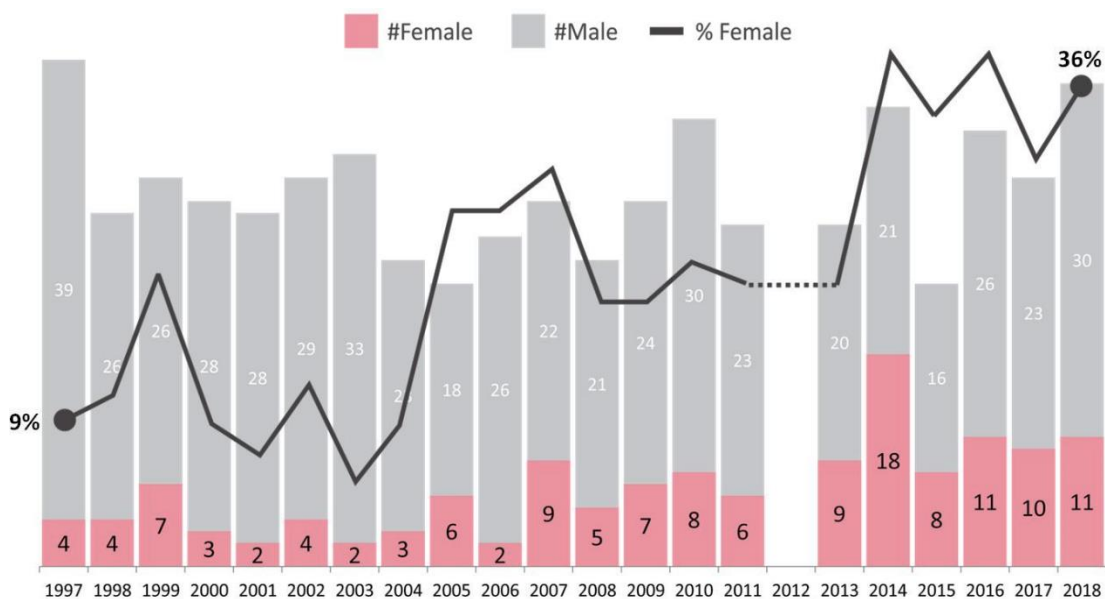


Figure 6: Department of Industrial Design first-year student enrolment numbers by gender, and female representation (percentage) from 1997 to 2018

An interesting observation is that women seem to have more staying power in the department. Figure 2 demonstrates that as year groups get smaller as students progress through the three or four-year programme (the BA is a three-year qualification, and the BA honours is a fourth year), the percentage of women increases. This indicates that although fewer women enrol into the programme, more men drop out. Furthermore, for the past five years, the Dean's Award for top achieving students in the department has consistently been awarded to female students. At surface level, these quantitative findings would suggest that women are currently successfully clearing the 'first hurdle' more successfully than men, and that indicates a promising trajectory. However, studies in the Global North investigating the experiences of students, tell a different story.

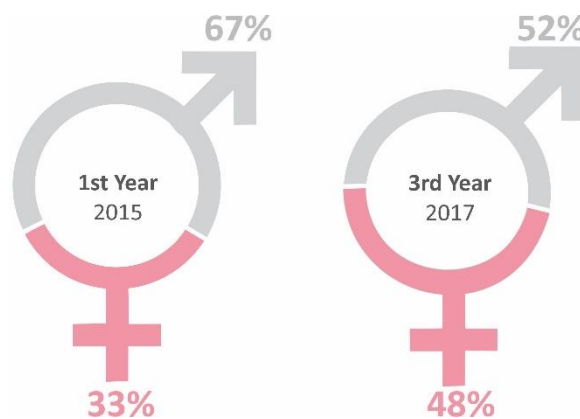


Figure 7: Gender split comparison of the 2015 Industrial Design student cohort in their first and third year of study

USA Industrial Design schools have equal ratios of male to female students (Barnhart & Walters 2018b). In 1993, a study including observations of 112 juries (a group/panel discussion more commonly used in the evaluation of work in the Architecture discipline) and a survey evaluating student experiences in three USA design schools, found that "female students were interrupted significantly more often during presentations than their male counterparts, and thus felt less confident of defending their designs to criticism" (Lockhart & Miller 2015b). A more recent study at Iowa State University unpacked the environment and culture of the design studio and the effect it has on women (Barnhart & Walters 2018a). Findings indicated that women preferred to work from home, away from the judgment of others, with some respondents claiming to be uncomfortable working in their university studios (Barnhart & Walters 2018a). Female students claimed to be afraid to ask questions because they felt that they are "rarely heard or fear sounding stupid" (Barnhart & Walters 2018a).

Echoing the South African data, gender diversity of the student population in Australian Industrial Design courses has also shown a notable increase in female graduates over the past 20 years. Lockhart and Miller (Lockhart & Miller 2015a) investigate the design knowledge development of young women studying industrial design in Australia. They provide insight into how gendered projects and environments can impact the skills development and engagement of women in the education process (Lockhart & Miller 2015a). Lockhart and Miller's investigation onto female student experiences at Australian universities showed that "the vast majority felt that gender was not a major factor in their experience of the course or how they were treated" (Lockhart & Miller 2015a). However, the vast majority felt that the nature of the

assigned projects aligned more with masculine interests, hindering their sustained engagement in the course (Lockhart & Miller 2015a).

Furthermore, the study showed that the experience of the workshop environment was perceived to be gendered with male students feeling more confident and women students having to grow their confidence throughout the course (Lockhart & Miller 2015a). These findings highlight the critical role of the educational experience in developing not only an appropriate skills base but also the confidence of female designers to promote their sustained engagement with the field (Lockhart & Miller 2015a). Barnhart and Walters (2018a) bring this point to home by questioning, "If women are fundamentally uncomfortable in current educational Industrial Design environments, how can we expect them to confidently move into professional practice?"

Many of the issues discussed above are echoed in STEM programmes, with problems such as the absence of female role models, curricula that are irrelevant to many women and pressure for women to conform to traditional cultural gender roles and stereotypes (Blickenstaff 2005). South African academia is dominated by men (Moosa 2017). Although more female students are enrolled at universities at an undergraduate level, there are more men at postgraduate master's and doctoral levels – resulting in fewer female academics (Moosa 2017). There is much value in having appropriate mentors and role models for female students, and to do this, the industry must transform, and the academy must become more gender diverse.

Gender diversity is important in both educational and professional levels. Not drawing on the tacit knowledge of women can lead to homogenous design solutions and single-sided design conversations (Kieran & McMahon 2017). "Homogenous student groups result in a lack of diversity in the tacit knowledge available both to individual students and limits peer learning in the studio environment" (Mayfield 2009). At a professional level, the underrepresentation of women in design creates a gender data gap (Criado-Perez 2019). The consequences of this data gap in the Industrial Design profession are, firstly, the loss of women's tacit knowledge in the design process, and secondly, the underdevelopment of products and markets in relation to the specific needs of women (Bruce 1985, p. 150; Criado-Perez 2019; Design Council 2018; Lockhart 2016, p. 3; Mayfield 2009; Ranga & Etzkowitz 2010). Products that are inappropriate for the needs and concerns of women impact their everyday lives. Such impacts can be relatively minor or irritating, such as struggling to reach a top shelf placed at an average male height or trying to grip an oversized cell phone. However, the consequences of living in a world built around male data can also have serious health/safety implications (Criado-Perez 2019). For example, car safety tests do not account for women's measurements (Criado-Perez 2019). As a result, women are 71% more likely than men to be *moderately* injured, 47% more likely to be *seriously* injured and 17% more likely to be *fatally* injured when involved in comparable car accidents (Criado-Perez 2019). These statistics are a result of how cars are designed and for whom (Criado-Perez 2019). The 'one-size-fits-men' approach to design, such as in hand tools that are often too large for women's hands, also further perpetuates gender stereotypes and "clichéd concepts of masculinity and femininity" (Kieran & McMahon 2017).

Conclusion

It is clear that there are still significant gender biases found in both the professional and educational Industrial Design contexts. As per the definition of Industrial Design presented at the start of this paper, we would like to change this situation. It is a difficult task to change an industry. A more realistic starting point is to build on the transformations that have already taken place in terms of gender equity in higher education in South Africa and at the same time learning from the experiences of women in other countries (Blickenstaff 2005). Such educational change could better prepare female students for the reality of the industry they

may work in, or more radically empower them to challenge the industry itself by beginning alternative enterprises.

Without change, design education will be limited in its ability to make use of the tacit knowledge and life experiences that individual students bring, but even these are hidden without skilled academics teasing them out. It is crucial for personal and professional development (Mayfield 2009), in an increasingly automated future, to come to the important realisation that as a designer, your own experiences are core to your success.

Although this paper has focused on gender disparity in the field of Industrial Design, gender is not the only imbalance evident in this field. Imbalances are seen in factors such as ethnicity, age, disability and social class (Mayfield 2009). The value of nurturing human diversity in design to address issues of inequality needs to be amplified through education (Gleason 2018). This will allow graduating designers to face the complexities of the economic, social, political and environmental upheavals that will become all the more evident in the fourth industrial revolution.

The findings of this small-scale study that are presented in this paper are just the beginning of a more in-depth and cross-disciplinary investigation into educational and industry experiences of women in South Africa. This will be expanded on through a three-year research project in partnership with Falmouth University that will collaboratively compare gender-bias in design in the two locations through the financial support of the UK Global Challenges Research Fund.

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