

# False Icons. Are we betraying our future female engineers?

## Abstract

This purpose of this practitioner-led research project is underpinned by discourses surrounding the lack of representation of women with the context of Science, Technology, Engineering and Maths (STEM). This paper focuses on the Engineering element of STEM. The government's STEM strategy has been in place since 2007. Generally, the agenda has been to encourage more women into these subjects. Within Engineering, the impact of this policy may at best be described as sluggish. Data shows in 2017 only 11% of the engineers are female (Peers, 2018).

This research critically considers the credibility of visual marketing images of women in engineering used within FE College settings. The pedagogical power of visual image is often an overlooked in Engineering education. This paper explores the use of visual methods (Metcalf in Manning and Stage, 2016) the impact of visual language (Berger, 1972) and how credible these images are when viewed and analysed by female engineering students and teachers using audit, focus groups and case study methods.

Voices of contemporary female engineers underpin this research regarding the importance of women in the design and implementation of tomorrow's world. There are cries for better role models "better visibility of what real engineering looks like today - preferably from a female viewpoint. We need to work on the images and the language that we use." (Hinson, Thompson and Dowling, 2018)

In addition to this is the historical narrative of how we construct ideas of Engineering (Sennett, 2009) and the seminal ideas of Berger from his text *Ways of Seeing* (1972). The findings of this study will be accompanied by recommendations regarding how images can be utilised within educational settings to support a more credible visual representation of the world of engineering.

## Introduction: To Engineer a Better Society.

*"To engineer a better society, we need people of different genders, races, and backgrounds solving our problems; therefore, to all those young women who may feel hesitant about entering this world in which we are the minority, I would say that the field of engineering will only be a male-dominated one as long as we allow it to be so. Start crossing those boundaries and maybe you can inspire others like you to do the same."* (Clark, 2013)

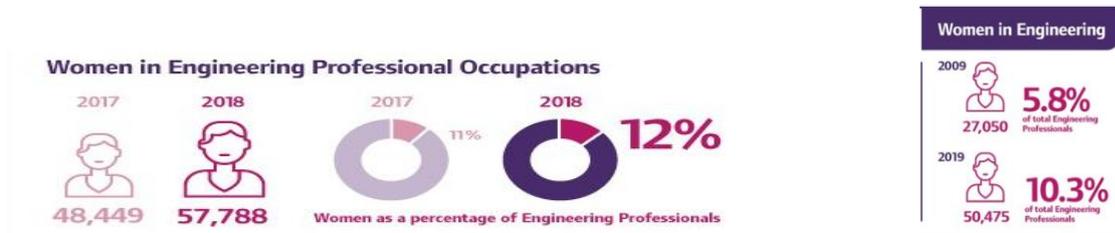
This research project is underpinned by discourses surrounding the lack of representation of women with the context of STEM (Science, Technology, Engineering and Maths). For the purpose of this study, the focus will be upon on the Engineering element of STEM; as a concept STEM provides too large a playing field of subjects. STEM subjects are not to be combined as one subject but are best seen as a collection of desirable subjects which it is

envisaged will enable its students to build the world of tomorrow. The drive and current government policy regarding STEM subjects aim to create the skills needed for an ever-developing information and technology driven culture. The Department for Education developed “The STEM Strategy - helping to empower future generations through science, technology, engineering and mathematics to grow a dynamic, innovative economy.” (Department of Education, 2017). Two years later the same Department noted that “Among STEM subjects, females had the lowest representation in engineering (14% of those saying they would study this at A level)” (Attitudes towards STEM subjects by gender at KS4 Evidence from LSYPE2 Department for Education, 2019)

FE Colleges are widely expected to be a catalyst for this, playing a role in recruitment and retention of women into careers in Engineering. It is within this COVID-19 period of lockdown with the reliance on online platforms that the visual image becomes even more important in supporting women to see their place in the Engineering field. The rules of the games are in flux. As a practitioner role within the college my role is based in the Applied Learning Foundation where I am positioned as a Teacher Educator. The college group is large with 7 colleges, 4 University Technical College’s (UTCs) and 2 secondary schools with international commitments to Saudi Arabia where they run four further education colleges for women. The impact of how we present women visually therefore has great impact. This study intends to instigate a change to increase the numbers of women within engineering by examining the credibility of images that are used to represent them. The emphasis here is on the visual materials and the construction and meaning students and teachers of engineering make from and place on them.

## **Literature Review: Levelling the playing field**

Primarily it is from the voice of current female engineers that begin to bring important issues to the fore. For example, voices such as those of Jamie Clark’s (Clark, 2013) and more recently Joysy John (2019) who remarks, “With fewer girls than boys choosing to study STEM subjects at secondary school and university, it also means that design and policy of critical technology, such as artificial intelligence (AI), will be driven mainly by men. This is a troubling prospect, as women make up half of the population and should have a say in the development of technology, in order to ensure that they are fairly represented. Change needs to happen quickly.” (John, 2019). Within the last 7 years the position of women in engineering remains the same, we need to recruit more women into engineering and the evidence shows this is slow progress. Although the data shows a 25% increase between, 2013-2018, which appears to indicate progress, on the whole women still account for 12% of the workforce, which would indicate the sector is still struggling with recruitment and retention issues. This can be seen in the realisation that women account for such a low percentage of the workforce. (Welcome to the WISE Campaign, 2018). Within the last statistical updates in 2019 it is disappointing that this number now can even be seen as decreasing to 10.3% (Welcome to the WISE Campaign, 2019)



In this literature review it is important to consider the importance of visual literacy and the larger influence it has. John Berger, whose seminal text from 1972 “Ways of Seeing” provided foundation for the importance of the visual image. The essence is that what we see is what we know. “It is the seeing that establishes our place in the surrounding world; we explain the world with words but can never undo the fact that we are surrounded by it” (Berger, 1972). If what we see are poor representations of women in Engineering then in turn this effects our perception. What we are presented with forms our views of what is reality. In terms of marketing images and our reliance on stock and often poorly considered images does education make a brave enough pitch into the metaphorical field of possibilities? “Publicity exerts an enormous influence and is politically a phenomenon of great importance” (Berger, p.153)

When we take into account the constructs of society in terms of the importance of practical education and the development of craft, it is difficult to see how women have participated. Richard Sennett (2008), in his work “The Craftsman” explores the role of work and the how taking joy, learning and meaning in the work are the practical application of the soul. Within this text we see the constructing of the positives and negatives of human endeavours and our need to create, to solve to build and master our own craft and that of our surroundings. It must also be taken into account how we socially construct and consider the field of engineering. Within this work it appears women are assigned to the index “Women: as child bearers, 23: and need craft, 57-58: as weavers, 23” (Sennett, p. 326) A few references to women crafts throughout time being a device to calm their sexuality. We live in a world that is to a degree a result of the social, cultural and historical past leading to larger questions of importance of women as makers and it their worth in society. An Institute for Fiscal Studies publication (2018) funded by the Economic and Social Research Council would support this in their findings that girls have low confidence within STEM based subjects at KS3? - viewing the sector as “male dominated”.

Metcalf, 2016, makes some profound observations when she states, “images have been used as illustrations for higher education’s history but rarely as a unit of analysis”. It is the images we use in education that add life to the narratives we tell. Female engineers are vocalising the need to “rebrand” engineering careers, and market them to students from school age to university leavers. “We need more female role models, and better visibility of what real engineering looks like today - preferably from a female viewpoint. We need to work on the images and the language that we use”.

*“What do you get when you Google “women’s careers in engineering”? Mostly*

*images of women in hard hats. Now, I am not knocking professions where you need that kit. But as a marketing tool for engineering careers it's not terribly imaginative! We desperately need to do a better job selling engineering careers - the whole amazing spectrum of them - to girls and women".*

(Hinson, Thompson and Dowling, 2018, p.1)

When we analyse the literature in this field of study it builds a picture of underrepresentation of women visually in many forms; our cultural preconceptions of women's place in the world of engineering and the importance of the visual as a way of women knowing their place in that world. The lack of research in the ways these images have a part to play in developing our understanding of our future in supporting a future engineers. How this literature translates into an educational setting within our systems and visual awareness of the world is the purpose of this research. We must also address the limitations of this and openly acknowledge that there are currently few females studying and teaching engineering within the colleges.

## Research Methodology

This research is based within the context of a group of FE Colleges and schools in the Oxfordshire and Berkshire area. As this group of Colleges and Schools is large comprising of seven colleges and three UTC's and four schools it is for the purpose of this study, the main focus is upon STEM course within the FE Colleges.

The methodology employed in this small-scale study adopts a constructivist-interpretive approach to the research, focusing on human enquiry into images with the "goal of understanding the complex world of lived experience from the point of view of those that live it." (Schwandt in Lincoln and Denzin, 1998 p.221)

Methodology includes; a collection of visual data (quantitative), two focus groups that include quantitative and qualitative methods as well as a case study.

1. Analysis of a quantitative collection of images and materials within the college that promote engineering courses within the college. These consist of
  - a. An audit of images in the college looking at:
    - i. The type of material i.e. prints, internet
    - ii. The values reflected in images containing people
    - iii. The value reflected in images with female engineers in comparison to male
    - iv. How the value of ethnic groups are portrayed
    - v. The visual impact of the images that contain females and the messages they carry- (within focus groups or within Activate Learning events.)
2. A focus group considering the experiences of engineering students from a range of courses with a number of quantitative and qualitative questions.
  - a. Using the data from the audit to try to quantify impact.
  - b. Data from a round table discussion based on the images.
3. A focus group considering the experiences of engineering teachers from a range of courses with a number of quantitative and qualitative questions.

- a. Using the data from the audit to try to quantify impact.
  - b. A round table discussion based on the images
4. A case study of a female engineering student studying engineering in the college

By employing methodology it will be interesting to see the triangulation between all the data sets and the relationship between quantitative and qualitative approaches.

Metcalfe in the chapter on “Visual methods in Higher Education” (in Manning and Stage, 2016) states that “Visual research methods are arguably the most under-utilised technique”. (Metcalfe, 2016 p.111). Although based on data collected in the context of higher education it is worth highlighting the benefits of taking such an approach. It can be argued that in an increasing visual nature of academic work, especially within the COVID-19 context that this is putting emphasis on interconnectivity and the online spaces we inhabit. Methods included in focus groups employed in the study include photo elicitation, where images are provided for analysis. Metcalfe also points out the use of the institutional imagery of how we view the educational world and when related to Berger’s work this adds a further dimension to how this approach is justified.

## Research Plan

The interventions are planned as shown in the following timeline table:

Date	Plan	Context of Research	Research Population
September October 2019	Submission, research question.	books, journal, internet and past research studies	Line Manager
	Focus research question.		Line Manager
	Initial reading, research	Library, Online and in discussions with colleagues.	Librarian
	October 24/25 <sup>th</sup> MA residential	University of Sunderland	MA Short course participants Lecturers
November December 2019	Reading, research.	Visit to site to visit the Engineering Facility.	Engineering lecturer  Business Development
	Researching methodologies.	Books, Library, colleague discussions.	
	Collection of Visual Images	On Site at Activate Learning	Careers Advisor at Activate Learning
	Finalising Method.		Line Manager
January February	Reading – initial outline.		

2020	Audit of Quantitative Images	City of Oxford College	
	February 6/7 <sup>th</sup> Sunderland MA Residential	University of Sunderland	MA Short course participants Lecturers
March April 2020 (Coivd-19)	Focus Groups  (Due to lockdown these were conducted online)	Blackbird Leys  Engineering Campus	Engineering Students  Engineering Teachers
	Reading Analysis.		
May June 2020	Case Study		Engineering student or teacher
	Poster Design (Submit by 15 <sup>th</sup> June)	University of Sunderland	MA Short course participants Lecturers
	May 14 /15 <sup>th</sup> MA Residential	University of Sunderland	MA Short course participants Lecturers
July August 2020	Online Conference - presentation  Writing research for submission.		
September 2020	Deadline 7 <sup>th</sup> September 2020		

## Ethical considerations

Ethical considerations have been made based on the five principles found within the BERA guidelines. (ETHICAL GUIDELINES FOR EDUCATIONAL RESEARCH, 2018)

Participants will be treated equally and with respect, consent will be requested and explained within the research project based on focus groups and the proposed case study. Participants will be informed they can remove consent at any time. A right to privacy and for the data to be kept anonymously will be made clear to participants. GDPR legislation will be adhered to in relation to data. Stakeholders in this research are the University of Sunderland and Activate Learning Group. The nature of the research has been overseen and supervised; ethical issues have been discussed within this time period of this research. Regarding the community of educational researchers, this research is of the researchers own work and will demonstrate citation and reference where relevant to the work of others maintaining integrity. Publication and dissemination are considered regarding the images used of people used in the available marketing material; dissemination of material will only be used if the identity of these individual has been pixelated. It is ethical to consider that the people in these images consider the use to be in the marketing; however, it is not assumed that this

entitled them to be used in the publication of this research in a way where their image is recognisable. It may be also be argued that these images are in the public domain however for the integrity of this research an ethical approach to GDPR regulations of uses of images has been adhered to. Researcher's wellbeing and development are supported by the policies within the working environment. Although this research has been funded by the Educational Training Foundation (EFT), the foundation has in no way influenced the conduct of the research or its outcomes.

This research aims to capture the fundamental way in which images play a part in the supporting/inhibiting credibility of careers engineering for females. There is a large government and policy push for this but are we truly making and promoting this in a believable way? The literature review demonstrates that current female engineers' options, beliefs around how our world is visually, historically and culturally constructed, illustrate credibility as a real concern. It is hoped that a set of results from this research that can be used to support future female engineers see a more authentic future.

## **Research Data analysis, Key findings and Recommendations.**

### **Data analysis**

An audit of images of all images relating to engineering courses was produced. The audit was completed by looking at the number of images of people within marketing images at the college. An audit of images furthermore shows disproportionate representation. (Appendix 2)

1. There are 18 images of people related to Engineering in the college material
  - a. This came from a base of print (3) and website images (15)
  - b. 1 female image in print and 2 on website – all different images
  - c. 1 on website female minority
  - d. Some of the images on line are used twice some total number of impressions is 21
2. Of all the images use, 21 (This is taken as the total number as they are image impressions as some used twice), 19% of these are female, 5% are female from ethnic origins
3. They images came from 6 sources, 2 print based and 4 website,
  - a. The 2 print based were the college prospectus (no images of females) and an apprentice leaflet(1 image of female)
    - i. Potential female students looking at the prospectus of the college would have no imagery to relate to.
  - b. The 4 website based engineering course websites on 50% of them contained images of females
    - i. 2 courses has no female images – HNC Electrical and Level 3 diploma

It can be seen in this audit in 3.ai that it is of recurring concern that there is no print image of females in the engineering material, if we look to Berger and revisit the idea that "It is the seeing that establishes our place in the surrounding world; we explain the world with words

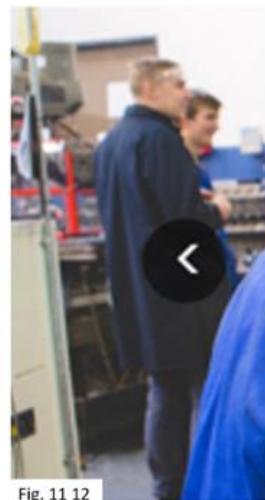
but can never undo the fact that we are surrounded by it" (Berger, 1972). Then does this approach support the role women need to play in being the architects of our future world? With 19% of images being women this suggests yet again that Equality and Diversity issues in the marketing materials is in urgent need of attention. The wise report shows 12% of women in jobs in Engineering and the images we are using are only fractionally higher in representation.

15 people gave consent in line with Ethics and GDPR to take part in an online (due to COVID-19) Focus group. 1 did not and this response was removed.

1. All taught or studied Engineering in the college group
2. 9 students took part
  - a. 6 male
  - b. 3 female
3. 6 Teachers took part
  - a. 3 male
  - b. 3 female

76% rating was recorded in the study by participants when asked to if images are important when choosing a career. This would support Berger and the female engineers calling out for more positive images of women in the field of engineering. A surprising finding in the online focus groups was the images that scored highest. Images of more mature white males (fig 6, 11 &12) scored highest in images irrespective of the gender or the position of participants in the research. This was added to by the fact that it scored highly whether you were male, female, a student or a teacher. We are ingrained in our beliefs about what an engineer should look like and this would relate to how Sennett shows us our past historical and social constructs. The high score additionally shows people working together and this human interaction and collaboration may also be a factor. Do we show the human side of engineering? Our bias leads us to these unconscious norms but it also shows us the important of the making, the doing and the vocational. Images also need to show how we interact within the engineering profession.

Fig 6 and 11&12



When we turn our focus to female images fig.9 and fig.10 scored higher as a first choice than fig.3 supporting the premise that women, looking like models in hard hats is not the best way forward. There was also a call in the focus groups for more use of diverse images and these to be less generic. There needs to be an awareness of the use of stock images in our marketing and a discourse of how these are best placed to create a future view of the world and not retain the status quo. To quote a female engineering teacher in the focus group “Fig 3 - looks like a fake, set up image, she isn't doing anything in the picture, no relation to an engineering role, just dressed up. The other two are less posed/ people look they're actually doing something related to Engineering”. It is also worth noting that females in the study saw these images as less supportive than the males.



When analysing and interpreting the data it was the Equality and Diversity aspect of the research that was touched upon in the literature review was found not fully developed as a main theme. Although the research was focused on women in engineering and the use of marketing images it became apparent that there are larger Equality and Diversity concerns. Equality and Diversity in education has its foundation in the Equality and Diversity Act, 2010. Within our institution the principles of this policy could be embedded further to create more recruitment of a range of students from diverse backgrounds by “harmonising provisions allowing voluntary positive action.” (Government Equalities Office, 2013) This action would be supported by the research undertaken by the Bridge Report (Strachan et al., 2019) that saw more applications from diverse groups when they adapted the images they used to promote courses. Within the online focus group one student remarked of the images use by the college were not as diverse as the students on that course although the lack of women on the course was a concern. “The images are sadly representative of my time in [redacted] College (we had a max of 3 women out of a class of 30 combined Mech/Elec students) but I know there is a higher proportion of women in the lower years for Engineering. [redacted] College; there are more mature students and more ethnicities than what is represented in the images.”

### A FEMALE PERSPECTIVE OF ENGINEERING EDUCATION

This case study focuses upon a female mature student studying Mechanical Engineering in central England. Its purpose is to provide a student view and experiences of engineering.

Her experiences of engineering growing up in the nineties revolve around the issues of sexism. *“You know girls didn’t do those types of things in those days”* even though she showed an interest in science and computing in was generally believed in the family home she would be a model. Her background and parental aspirations for her were limited and on top of this she found education limited her choices further. Choosing from limited options in Y9 within technology looking back she felt was also limiting *“I think it’s a shame because I enjoyed resistant materials as well and you’re expected to do two weeks for each of them and your expected to choose one of them and actually I enjoyed food technology and resistant materials but you just get to choose one”*. She sees it now that Engineering should have more of Core status in education *“because everything is engineering from food production down to medical devices and computers and machinery, everything so everything we do has an engineering element I think it needs to be a core subject personally and you concentrate on all of those things because it’s a cultural thing that everyone does”*.

She came to engineering though work not through education. *“I didn’t know what I was going to do when I left school and it was because my husband at the time got an apprenticeship as a welder ...I just applied for a job thinking I’ll be sweeping the floor or something but then I ended up in the Admin department in the materials receiving”*. She fell into engineering and by chance discovered something she loved.

Currently she is studying HNC Mechanical Engineering one day a week and working in engineering. She sees in work a low proportion of women in the place she works maybe 5% of the staff are women and they are mostly admin and secretarial staff. Within college there are only 3 women out of a class of 30, although she recognizes a higher proportion in the lower years. Where she is based at the moment she does see a broader range and change *“I think girls are definitely considering it more so but it definitely needs more done to it”*

She has had to make difficult choices to pursue her career, turning down jobs that were not supportive of her education to work with companies that would support her. She also feels concerns about how her job would be if she wanted to start a family and how this negates her personal and work life. *“I think it needs to be more flexible with how people are working and think with this current crisis this will come about and I think they leave to have a family as there is that gender issue there, it needs to be more flexible. 70 hour weeks, long hours although in public sector it’s a lot better, but in the private ... they have a masculine way of working.”*

In relation to images of female engineers she says *“I think they are quite important and also we don’t know what engineering looks like and we get the generic images of someone wearing a hard hat, and that’s only a little part of it. We need more images of design, testing, engineering is so broad it could be, so much you can out in there, and we seem to limit ourselves with a architecture image or of a some girl on site”*

She has had to make choices and show strength of character to pursue her career; but she shows there are real benefits to the job. She is never bored, she has increased her knowledge and understanding and it has opened her up new ways of thinking. Her advice to education is to start engineering education at an early age, make clear distinctions between engineering and trades and to keep it diverse. In her own words again. *“You only really think about these things when you when you study them. Actually, even those tiny components you don’t really think about that you use every day, someone had to design them and someone had to make sure they work, all these tiny little things that pin things together it’s all based on human knowledge”*

## Key Findings

- Images employed in the promotion of Engineering Education are disproportionate in terms of the representation of gender and in the multitude of ways they reflect the nature of engineering practice. This suggests there is a bigger diversity and misrepresentation issue than is currently widely assumed.
- Images play an important part in how we see ourselves in the world. Cultural constructs continue to affect our views of ourselves and our views of the world.
- The voices of women engineers in the study are important and add to the much underrepresented voice of engineers.
- Overuse of stock images that are not representative of female engineers is widespread in the promoting of Engineering Education.
- Cohorts of engineering students in our colleges are often more diverse than generally promoted and there are Inconsistencies between print and web material.

## Recommendations

- Revisit the marketing processes used to promote Engineering Education in college.
- Females students need to see themselves represented visually (Berger, 2008)
- The BRIDGE project (2019) indicates that more gender neutral and inclusive marketing materials in the construction sector encouraged more women (8% increase) to apply. This approach would be beneficial.
- Stereotypes still play a part of our culture and there is work to be done in giving consideration into the images we employ.

## Conclusion – You can't be what you can't see

In 2018, women in STEM made a video entitled “you can't be what you can't see” (British Broadcasting, 2018), more recently this idea resurfaces in another BBC piece based on increasing BAME representation in Senior Leadership in education (British Broadcasting, 2020). Contemporary conversations are relevant in social today about how we view our identities. Visual images are becoming more prevalent and although overlooked in educational research it is important we address what our future students see and how to create a more equal and diverse playing field for future females in Engineering. Images are powerful and it is hoped that the college I work at and other colleges will start to consider more how images support female applicants to see their place in the world. Through this cultural conditioning can be dismantled to improve the gender imbalance in the engineering profession.

Words 3842

**All data is available upon request.**

**Appendices included in this report below to add context:**

- 1. Dissemination**
- 2. Table of Audit of College Images**
- 3. College Images**

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# Appendices

## Appendix 1

### Dissemination strategy

It is the intention that this research be shared in the following ways:

- Conferences
- In organisational department
- Podcast
- You tube – social media
- Research Journal - Activate learning
- EFT Research Portal
- STEAM Research Group at Oxford Brookes University

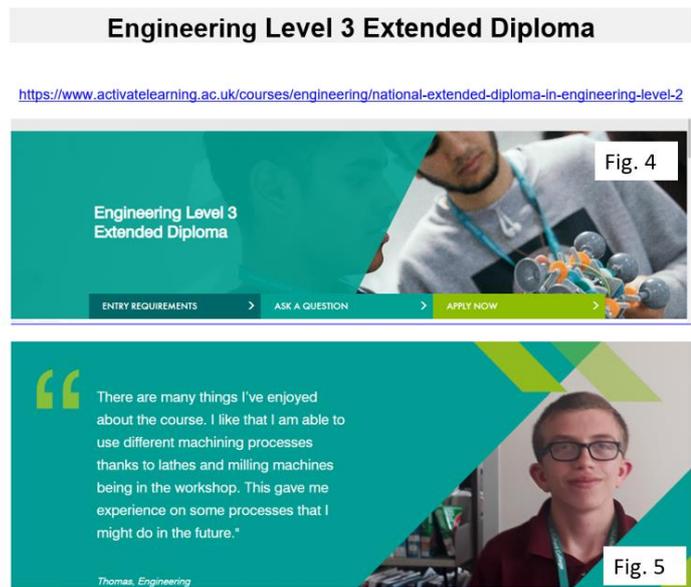
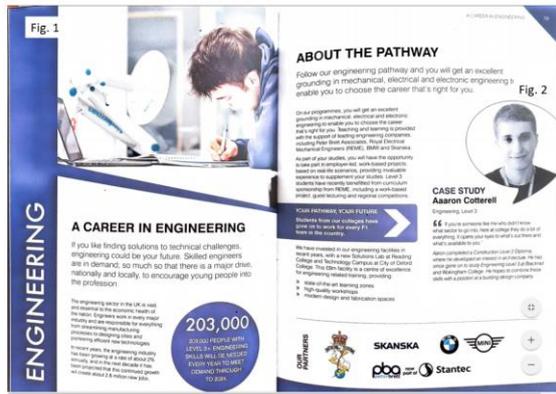
## Appendix 2

Audit of images contained within Activate literature taken within the time period of January 2020 regarding Promotion of Engineering Courses									
Image location	Engineering level or route	Division of Engineering	Number of images related to Engineering	Number of images of people	Number of images of male	Number of images of female	Number of images of ethnic minorities male	Number of images of ethnic minorities female	Comments
Print	Diplomas and Apprenticeships	All Generic Prospectus	2	2	2	0	0	0	Fig 1 Fig 2
Print	Apprenticeship	Generic Apprenticeship leaflet	1	1	0	1	0	0	Fig 3
Website	Diploma	Level 3 Extended Diploma	2	2	2	0	1	0	Fig 4 Fig 5
Website	HNC	Mechanical	6	9	7	2	1	1	Fig 6-14 Rolling images on Website
Website	HNC	Electrical	6	6	6	0	0	0	Fig 15-17 Repeated images of HNC Mechanical Rolling images on website
Website	Access to HE	Level 3 Diploma	1	1	0	1	0	0	Fig 10 Reused Image Other images not relating to engineering but to HE courses Nursing and midwifery
TOTALS			18	21	17	4	2	1	
Percentage				100%	81%	19%	10%	5%	
Fig 10, 11, 12 and 17 are used twice.									

**Table 1**

# Appendix 3

These images are in context but focus group participants viewed them both in and out of context.



## Mechanical Engineering Higher National Certificate (HNC)

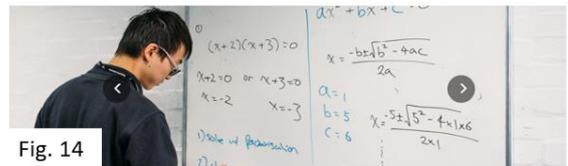
<https://www.activatelearning.ac.uk/courses/engineering/btec-hnc-mechanical-engineering>



Rolling images – not always in sight – the female image



Fig. 11 12



## Higher National Certificate (HNC) Electrical/Electronic Engineering

<https://www.activatelearning.ac.uk/courses/engineering/btec-hnc-electrical-electronic-engineering>



Fig. 11 12



## Access to HE: Engineering Level 3 Diploma

<https://www.activatelearning.ac.uk/courses/access/access-to-higher-education-diploma-engineering-1>



Access to HE: Engineering Level 3 Diploma

Fig. 10

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“ The Access course has given me the opportunity to enter a career and a degree that I never thought I would be able to achieve. It's made me also realise that I have academic skills and that you can retrain at any point in your life.”

*Andrew, Nursing and Midwifery*