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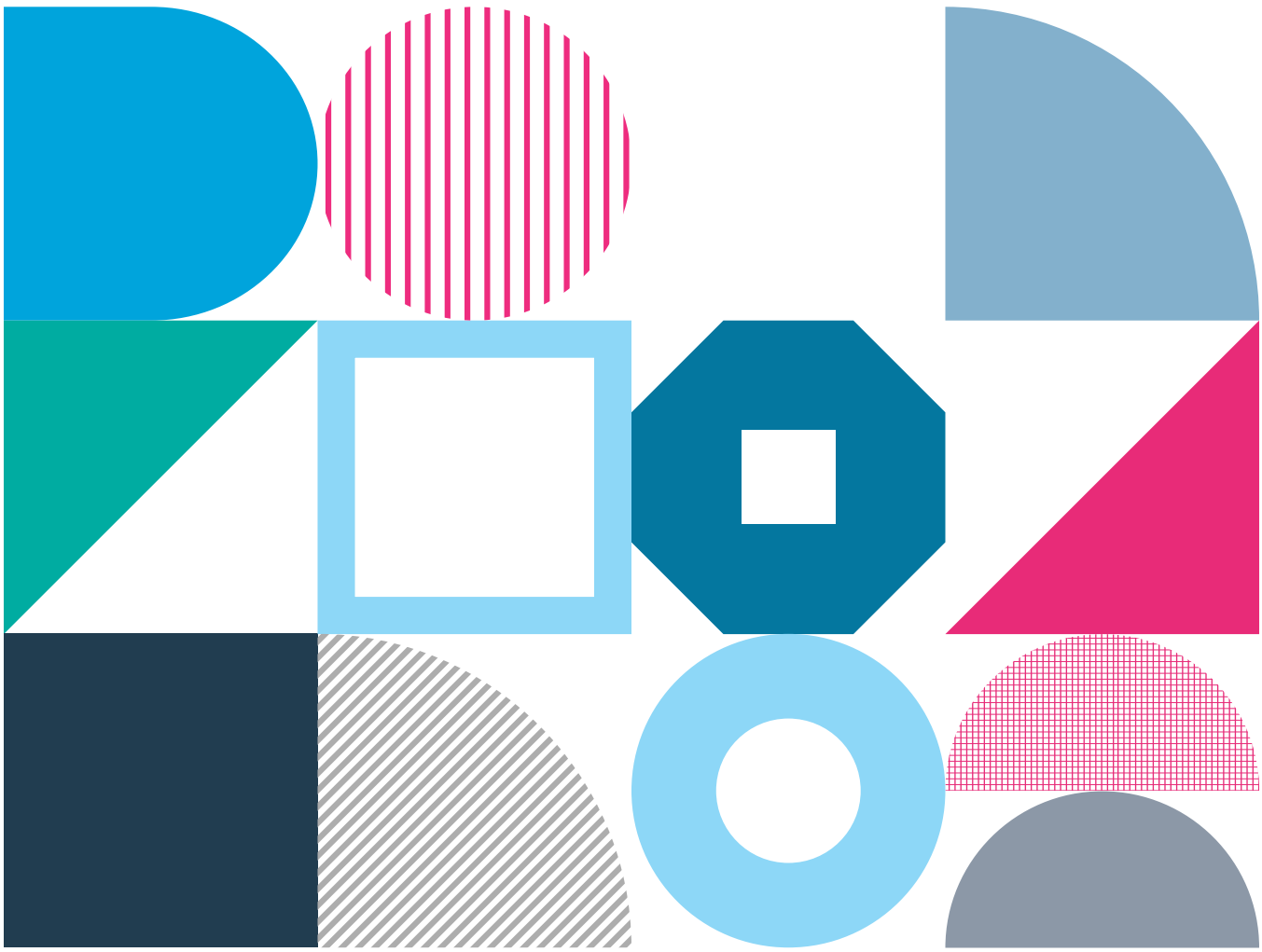
ATKINS
Member of the SNC-Lavalin Group

CAREER DEFLECTION

EXPLORING DIVERSITY, PROGRESSION, AND RETENTION IN ENGINEERING



Institute for Employment Studies

IES is an independent, apolitical, international centre of research and consultancy in public employment policy and HR management. It works closely with employers in all sectors, government departments, agencies, professional bodies and associations. IES is a focus of knowledge and practical experience in employment and training policy, the operation of labour markets, and HR planning and development. IES is a not-for-profit organisation.

About Atkins

Atkins (www.atkinsglobal.com) is one of the world's most respected design, engineering and project management consultancies, employing over 19,000 people across the UK, North America, Middle East and Africa, Asia Pacific and Europe. We build long-term trusted partnerships to create a world where lives are enriched through the implementation of our ideas.

About SNC-Lavalin

Founded in 1911, SNC-Lavalin is a fully integrated professional services and project management company with offices around the world. SNC-Lavalin connects people, technology and data to help shape and deliver world-leading concepts and projects, while offering comprehensive innovative solutions across the asset lifecycle. Our expertise is wide-ranging — consulting & advisory, intelligent networks & cybersecurity, design & engineering, procurement, project & construction management, operations & maintenance, decommissioning and sustaining capital – and delivered to clients in three strategic sectors: EDPM (engineering, design and project management), Infrastructure and Nuclear, supported by Capital. People. Drive. Results. News and information are available at www.snclavalin.com or follow us on Twitter @SNCLavalin.

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Acknowledgements

This research has been commissioned by Atkins, supported by Good Relations, to explore diversity in the engineering sector and how this has changed over the last 10 years. The authors are indebted to those at Atkins and Good Relations who helped steer the direction of the research. The findings and conclusions presented in this report are however those of the authors alone.

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FOREWORD

The world is changing fast, and engineers lead society in helping shape the infrastructure to tackle the global challenges of population growth and climate change. That infrastructure provides a foundation for our quality of life far into the future; the roads and bridges we shape today, lay paths for our grandchildren to follow.

As a leading engineering business, we have a responsibility to design, deliver and operate lived environments that work better for all. This responsibility has led us to commission this report from the Institute for Employment Studies, a report to explore the factors which can help us unlock the necessary diversity of talent to meet the challenges of tomorrow.

Delivering world-class infrastructure to meet the needs of tomorrow requires a team united both by their exceptional talent, and by their ability to recognise and reflect the needs of the society they serve. Such talent is by definition exceptional, and to find it we as an industry have long recognised our responsibility to attract as wide a pool of talent as possible into the world of engineering.

Working together, here at Atkins we have succeeded in increasing the proportion of female engineering and technology undergraduates in the UK by five percentage points over the last decade, and yet I still fear much needed talent continues to go to waste and so our work on social inclusion and supporting entrants with disabilities is ongoing.

However, when I look across my peers within the industry, I recognise that most share a background similar to my own, and that diversity declines dramatically at higher levels of seniority. While a natural lag is to be expected, it cannot be denied that career progress for those who are not white and male occurs at a slower pace. Over the course of time, it appears that career progression for many is being deflected away from what they as individuals, and we as employers require to make the most of their exceptional talents. Such “career deflection” is not unique to engineering, but as this report shows, it is more pronounced and obstructive to individual and collective progress within our industry than any of the other professional careers considered in this report.

The erosive impacts of ‘career deflection’ on the earning potential and progress of women, ethnic minorities and disabled employees within engineering is a major cause for concern. Women are leaving our profession at twice the rate of men, while more than half of ethnic minorities will abandon their chosen career.

At current rates of progress this means it will take well over a century for there to be the same number of women as men working in our sector, and 50 years for the proportion of ethnic minorities in engineering to reflect wider society. This is neither acceptable nor sustainable.

As an engineer, before proposing the solution, I have been trained to effectively define and explore the problem. What is holding back these exceptional talents, and how can we as an employer and industry act to effectively tackle barriers to their progress? As this report explores, good intentions are far from enough, indeed certain interventions such as early promotion into management positions may even be counterproductive. At Atkins we are extremely proud of the affinity networks that we have built, providing a space for people to come together and address shared challenges. As we move forward in tackling “career deflection” the reflections of these networks on this report will help us address the underlying barriers to career progression.

I can commit that we will continue to address underrepresentation across our industry and workforce, and that the findings of this report will inform and lead change within Atkins, and I am hopeful that they will do the same within your organisation. More than just commercial imperatives, I see diversity and equality of opportunity as our responsibilities as a business committed to leading the change we want to see. We know that it won’t be easy. But these are important steps in our journey to become an even more diverse and inclusive business, and we’re committed to making progress and working with the wider industry to support change. Why? Because simply put, it’s the right thing to do.

Richard Robinson
Atkins
CEO UK & Europe

METHODOLOGY & APPROACH

Definitions

This report provides an independent assessment of diversity in engineering. It explores how diverse groups progress within the engineering profession, a profession that is dominated by white males; and seeks to understand what are the factors that hold some people back and propel others forward. It explores the scale and nature of 'career deflection'.

Key to this report are three definitions:

- **Career deflection:** Atkins, a member of the SNC-Lavalin Group, design, engineering and project management consultancy, funded this study and they describe the barriers to progress within a career in engineering as "career deflection" reflecting how the early hopes of engineering graduates are being distorted under an applied load over time.
- **Diversity:** Diversity is often defined in relation to the Equality Act (2010). This sets out the personal characteristics that are protected by the law and the behaviour that is unlawful, and identifies 9 protected characteristics: age, disability, gender reassignment, marriage and civil partnership, pregnancy and maternity, race, religion and belief, sex and sexual orientation.
- **Engineering:** The focus of this report is those working in engineering – but this could include those in engineering roles, those working in engineering sectors, or both (those working in engineering jobs for engineering companies). **For the analysis of national data presented in this report, engineering is defined as those working in engineering occupations, regardless of sector.** Engineering occupations are defined using the standard occupational classification (SOC 2010) and are based on the EngineeringUK footprint (as used in their annual 'State of Engineering' reports). This provides a broad occupational definition. The list of occupations included in this definition are provided in Appendix A.

Approach

To explore career deflection in engineering we undertook descriptive analysis of national data sets (the Labour Force Survey and Understanding Society), identifying diversity trends within engineering and making comparisons with other professions; and a review of the policy, research and academic literature on career progression within engineering and related professions and sectors.

Data analysis:

- Review of existing national datasets to understand representation in engineering and how the make-up of those in engineering occupations has changed over the past ten years.
- Assessment of career deflection across four dimensions: retention, progression to managerial or supervisory responsibilities, progression to higher pay, and progression to higher occupational levels.
- Analysis focuses on women, ethnic minorities, and those with disabilities. Limitations in the available data meant it was not possible to explore other diversity or protected characteristics – which in itself is a notable finding.
- Ten years of data was used to provide longitudinal and trend analysis: April to June quarters from 2011 to 2020 for the Labour Force survey; and analysis of wave 1 (2009-2011) and wave 10 (2018-2020) of Understanding Society.

Literature review:

- Engineering is defined differently across the various studies identified in the literature, and thus can cover engineering industries, engineering companies and also engineering occupations, careers or pathways.
- Engineering is often closely related to or incorporated within construction in literature (and so difficult to isolate).
- In this report career deflection is explored as barriers to career progression and advancement which can include individual, organisational and systemic barriers.
- Our search focused on the experiences of women, those from ethnic minorities, disabled people, and LGBTQ+ individuals.
- Over 70 papers were reviewed and much of the evidence is drawn from qualitative methods seeking to establish the lived experience of the individual in the industry/profession.
- It is however important to acknowledge intersectionality, the interconnectedness of social categories, and to recognise that every individual will have many identity points that will impact them differently.

AT A GLANCE

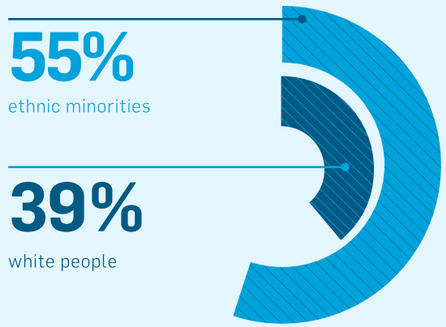
Career deflection is driving women and those from ethnic minorities away from engineering.

Over the course of ten years, career deflections such as stereotyping, isolation and bias **result in women leaving engineering at twice the rate of men.**

Proportion leaving engineering within a decade

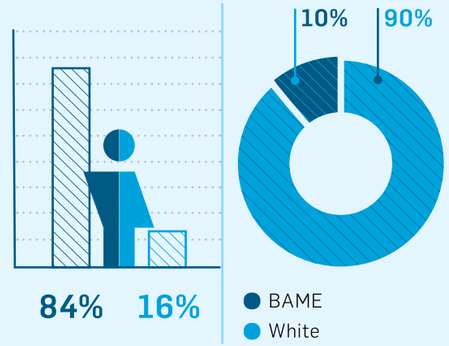
Those from ethnic minorities are 16 per cent more likely to leave than their white peers.

More than half of ethnic minorities abandon their career in contrast to 39 per cent of white people.

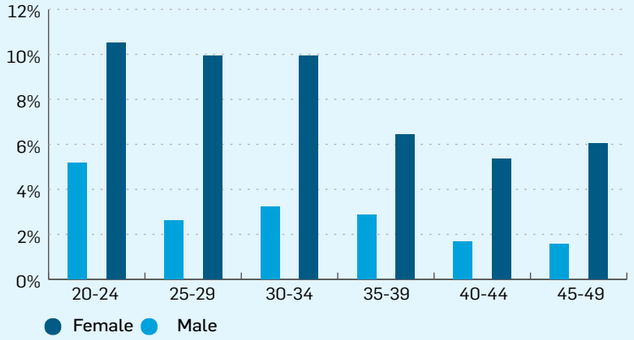


Male/Female split for engineering managers

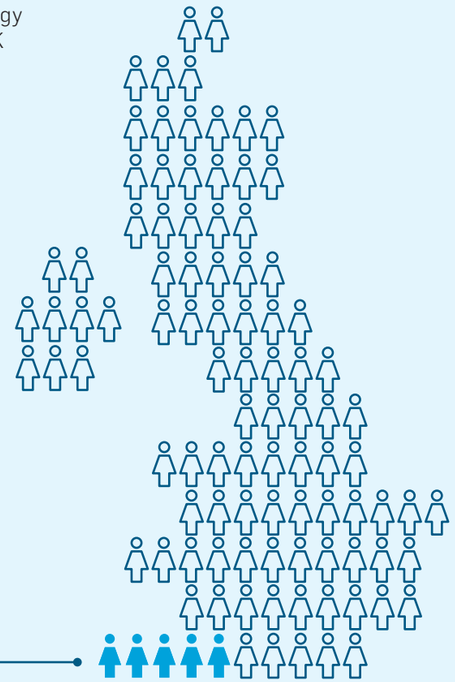
As it stands in UK engineering, women make up only 16 per cent of the work force and BAME employees only 10 per cent.



Rates of outflow to other sectors by gender and 5-year age group



Over the last decade the proportion of female engineering and technology undergraduates in the UK has **increased just five percentage points.**



5%

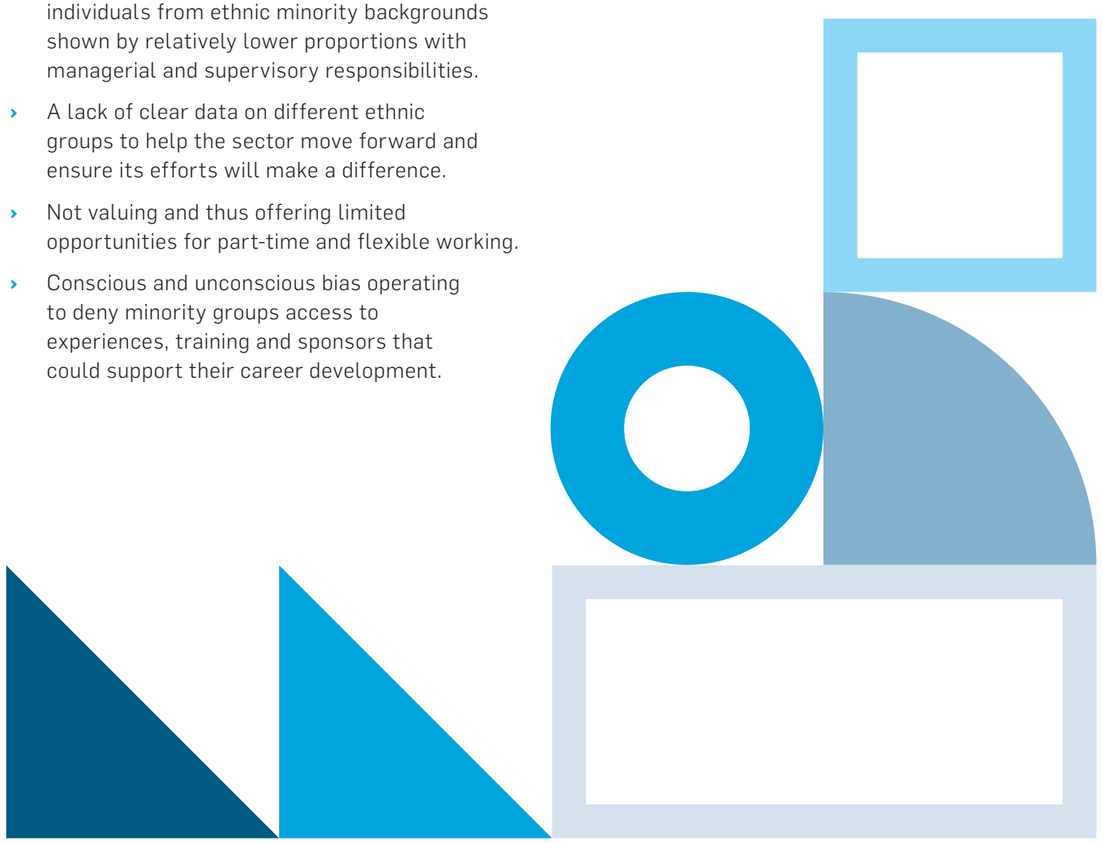
At current rates of progress it will take **more than a century for there to be the same number of women as men working in engineering occupations overall.**

EXECUTIVE SUMMARY

Key Highlights:

The challenges facing engineering are:

- A gap in the representation of women at all levels including senior roles and poor retention of women particularly in their early career.
- Poorer long-term retention of those from ethnic minority backgrounds despite being well represented in engineering roles as a whole, and lower rates of progression of individuals from ethnic minority backgrounds shown by relatively lower proportions with managerial and supervisory responsibilities.
- A lack of clear data on different ethnic groups to help the sector move forward and ensure its efforts will make a difference.
- Not valuing and thus offering limited opportunities for part-time and flexible working.
- Conscious and unconscious bias operating to deny minority groups access to experiences, training and sponsors that could support their career development.
- Individuals in the minority feeling isolated, marginalised and lacking confidence and self-belief in their potential to progress.
- Discrimination experienced by minority groups despite existence of policies and practices to support diversity and tackle inequality.



Key Findings:

Representation:

- Women are significantly under-represented in engineering occupations. Over the last decade, women accounted for 11% of engineers and 16% of engineering managers and professionals but make up 47% of all those in employment overall. Engineering has lower proportions of women than all other comparator professions (architecture, science, law, and business and finance). The numbers of women entering engineering have been increasing over time but they still account for a very small proportion of the workforce and at the current rate of increase it will take almost 100 years to achieve parity with their overall workforce representation.
- Ethnic minorities and disabled individuals appear to be more evenly represented in engineering occupations overall. Over the last decade, each accounted for 10% of engineers just slightly below the proportion of each in the overall labour market. Indeed the level of disabled people in engineering was found to be higher than many other comparator professions (architecture, science, law), though similar to business and finance professionals. However, disabled individuals were slightly underrepresented in engineering managerial and professional roles.
- It should be noted that neither ethnic minorities nor disabled individuals are homogeneous groups and so these figures may hide differences for different ethnic minority groups and those with different conditions or impairments (something which was not possible to explore within the datasets used).

Retention (early and mid career, aged 20 to 49):

- Women have had lower retention rates in engineering occupations over the last decade compared to men. The retention rate for women has fluctuated between 87% and 91%, with the male retention rate stable at about 95%. The gap in retention rates is also larger compared with other professional occupations.
- The lowest retention rates for women are found for those aged 20 to 24 (career entrants) and are generally low for those under 40. The highest rate for women is for those aged 40 to 44.
- Overall women are more likely than men to leave engineering, and one in ten women aged 20 to 34 will leave their role in an engineering occupation within the space of a year, compared with 3 to 4% of men in this age group.
- Additionally, women have lower retention rates in engineering professions than many other professions (law, business and finance and architecture) and the disparity in retention rates between men and women is greater in engineering than in other comparator professions. Of the professions explored only science occupations had a poorer record of retention of women. Understanding Society finds that men are approximately twice as likely to remain in engineering roles for at least 10 years compared with women (both in terms of a continuous presence or with some time out of the profession).
- Retention rates for ethnic minorities in engineering roles have been improving over time and are now on a par with those from white backgrounds. The Labour Force Survey finds that over the past decade the average retention rate in engineering occupations for those from white backgrounds was 95% and was 92% for those from ethnic minority backgrounds; and by 2020 the retention rates were 93% and 94% respectively.
- Exploring other professions, retention rates for ethnic minorities, and the disparity in retention rates by ethnicity, were worst in science occupations and best in architecture. There may however be an issue with longer term retention (over a ten year period) in engineering with proportionally fewer individuals from an ethnic minority background having a continuous presence in engineering than found for those from white backgrounds.

- Retention rates for disabled individuals in engineering roles have also been improving over time and are now almost the same as found for non-disabled individuals (92% and 93% respectively in 2020).
- Science professionals again have the greatest disparity in retention rates and the lowest retention rates for disabled individuals among the professions analysed, and architecture the best rates.

Career progression (all ages):

- Around a third of those in engineering roles have managerial or supervisory responsibilities. This differs little according to gender or disability, there was however some disparity between the proportion of those from ethnic minority backgrounds and those from white backgrounds with managerial or supervisory responsibilities (31% and 35% respectively).
- Analysis of pay data for women and men in engineering occupations shows very little difference in rates of increase in pay at either an aggregate or individual level. Thus, from the data sources analysed, there is no evidence of differences in the ***rate*** of pay progression, although pay ***levels*** differ between men and women (which is likely to reflect difference in the occupational profile of men and women as a result of wider systemic drivers which impact overall pay).
- Our review highlights that there is substantial literature on career choices, career entry and talent pipelines, but there has been less attention paid to tracking individuals, particularly from minority groups, once in employment and in organisations. Much of the research seeking to understand how careers do or don't progress, what facilitates or hinders progression and how this impacts on individuals and retention, has focused on capturing lived experiences through interviews often with small numbers of individuals.

Career deflection:

- Barriers to career progress can be categorised into three broad groups – 1) personal/internal 2) situational/external and 3) the interface between these. The Career-Barrier Inventory (CBI-R) identifies potential personal/internal career barriers as: lack of confidence, multiple role conflict, decision-making difficulties and dissatisfaction with career. Situational/external barriers include: discrimination (sex, racial), disability/health conditions, discouraged from choosing non-traditional careers, disapproval by (expectations of) significant others, job market constraints. Interface barriers include inadequate preparation and difficulties with networking.
- Barriers are not static and can change over the life-course. They may differ according to role or level or even location in the organisation. They differ by gender with studies finding women anticipate and face more barriers to progression and retention than their male peers and that gender creates additional and specific barriers over and above other minority identities.
- The anticipation of barriers can lead to individuals selecting themselves out of certain industries and professions, in favour of more viable ones with few obstacles and more opportunities.
- Barriers to engineering or related sectors and professions include: stereotyping; macho cultures creating 'chilly environments'; unchallenged discrimination and bias; lack of flexibility in working patterns and arrangements coupled with norms of overwork, excessive workloads, and expectations of constant availability; lack of career resources or opportunities; lack of role models; isolation and lack of support, mentoring or networks; and concerns over disclosure (of disability, sexuality or gender identity) coupled with a culture that is perceived to reward those who fit the mould of the 'ideal engineer'.

Recommendations

To effect real change to address career deflection we recommend the engineering profession consider actions across the following three areas:

1. Improve data, analytics and research

- Data collection - better monitoring of analytics with improved workforce and diversity data.
- Undertake further research on barriers to progression and independent evaluations of diversity initiatives aimed at preventing career deflection to understand what works. In order to support improvements in policies and practices.
- Share data and good practice between and across industries , and look to learn from those with good records in participation, retention and progress for minority groups such as the architecture profession.

2. Modernise diversity policies, training and development

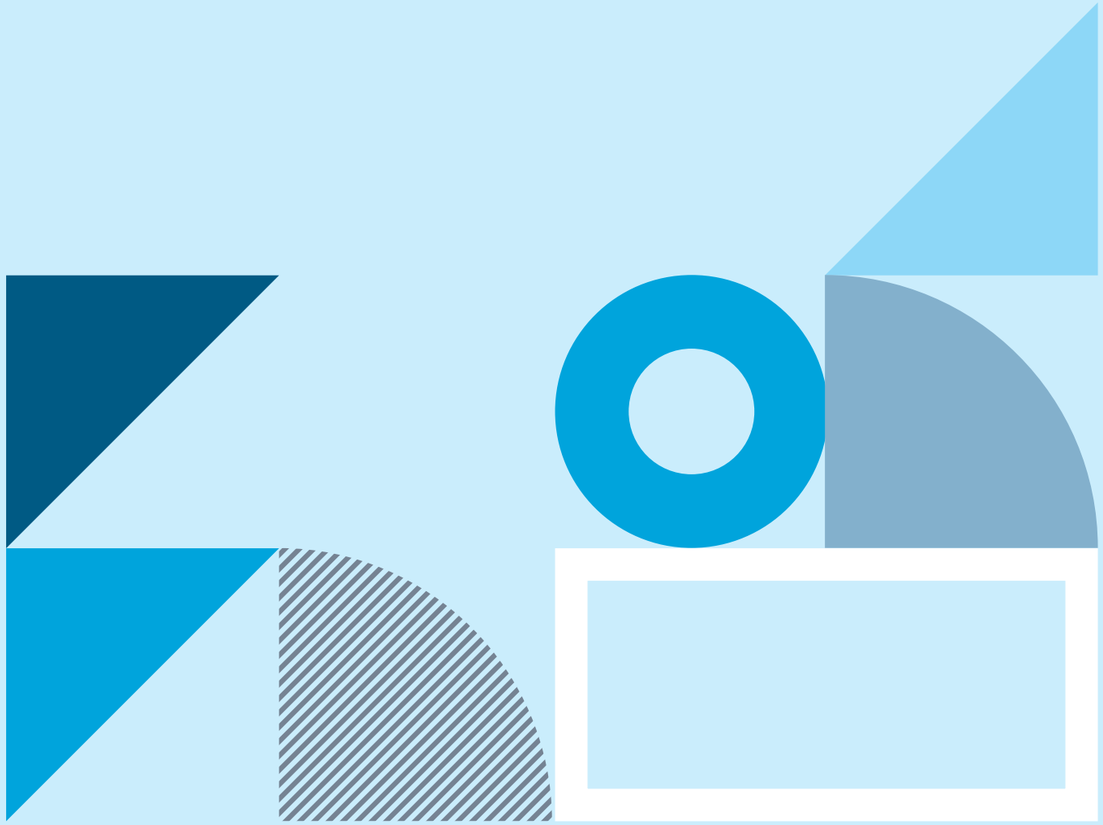
- Promote and normalise alternative working patterns, develop supportive return to work policies and move away from presenteeism and long hours working cultures.
- Ensure transparency in progression and promotion procedures.
- Ensure equal access to development opportunities including training and challenging experiences and tasks.
- Provide a range of employee support including role models, networks, mentoring, supportive line management and careers support.
- Promote inclusion whilst tackling discrimination head on by understanding how it can be experienced or perceived and take it seriously with a zero-tolerance approach combined with the promotion of inclusion as an organisation-wide commitment backed by training.

3. Focus on culture of diversity and an inclusive corporate character

- Changing the culture of organisations, the profession and sector to provide conducive contexts for policies to flourish and this involves engaging everyone in culture change, offering and promoting flexibilities, establishing responsibilities and accountability (particularly at senior levels), providing training, and creating a sense of belonging and voice.
- Tackle the male biased culture by promoting collaboration and a sense of belonging in a culture where individuals feel they are able to disclose their identities and recognise the limitations inherent in a fixed and singular notion of an ideal engineer.

01

INTRODUCTION



This report presents the findings of a study to explore diversity in engineering and how this has changed over the last 10 years.

It explores how diverse groups progress within engineering occupations and what factors act as barriers, which may lead to **career deflection**, and what act as levers or enablers to progression within engineering; and thus what engineering organisations can and should do to improve diversity and reduce loss of talent.

Over the last decade the engineering profession has taken steps to move away from being a mainly white and male-dominated. To work to achieve this, it has primarily focused on increasing the diversity of entrants. This includes an emphasis on and analysis of the diversity of graduates entering higher education and of recruits to the engineering profession, particularly in the work undertaken by the Royal Academy of Engineering. However little attention has arguably been placed on experiences within engineering and an engineering career or on efforts to ensure that the likelihood of remaining in the profession does not differ by background and diversity characteristics.

The work on increasing the supply has had mixed results. Cohorts entering higher education (HE) courses in engineering have become more diverse in recent years but there is still some way to go. Women remain significantly underrepresented in engineering and technology courses, disabled individuals are underrepresented, and, although engineering and technology is more ethnically diverse than most other subjects in HE, gaps in attainment between those from white backgrounds and those from ethnic minority backgrounds persist.

Also, women and those from ethnic minority backgrounds are less likely to be employed in the engineering sector or to be in engineering-related roles six months after graduating from HE (EngineeringUK, 2020; EngineeringUK, 2019).

Work continues to try and improve the diversity of the talent pipeline and significant efforts are being made to increase diversity in recruitment to engineering firms. However, attempts here will be nullified if attention is not broadened to other parts of the career journey or pathway. Poor retention among certain groups within the industry coupled with potentially lower progression opportunities and greater barriers to progression, can lead to underemployment (not able to make the best use of their skills and knowledge) and a loss of talent, and to engineering struggling to retain a mixture of talents that reflects wider society. Increasing the supply of entrants will not lead to a more diverse workforce if individuals leave at a faster rate than they can be replaced. Key organisations such as Atkins are therefore concerned that career deflection leads to a lack of inclusivity and undermines retention, leading to a loss of talent to the sector and profession and a wider cost to society.

This report explores career deflection - potentially resulting from barriers to progress within a career in engineering and retention – for diverse groups.

1.1
Aims and objectives

The research had three main aims:

- To investigate the extent to which representation, retention and progression rates for underrepresented groups in engineering compare with the average for engineering.
- To investigate the reasons why underrepresented groups may not progress as quickly.
- To identify potential solutions and make recommendations for actions for the engineering profession and sector.

1.2
Report structure

The report is structured as follows:

- **Section 2 - Diversity in engineering.**
  This section explores how engineering has changed over the last 10 years with a focus on women, ethnic minorities, and disabled individuals within engineering occupations, and presents estimates for when, at the current rate of progress, the engineering profession will be a level playing field for all.
- **Section 3 - Assessing the incidence of career deflection.**
  This section explores career deflection across four dimensions: i) Retention; ii) progression – gaining managerial or supervisory responsibilities; iii) progression – change in pay, and iv) progression - movement at the occupational level.
- **Section 4 - Understanding the nature of career deflection.**
  This section details how career deflection is experienced in engineering and related sectors and professions based on the findings of a literature review and sets out how these sectors and professions are or should be working towards inclusion.
- **Section 5 - Recommendations for the sector**
  This final section identifies future actions the engineering sector and bodies could take to prevent future career deflection and make the sector more diverse at all levels.

02
DIVERSITY IN ENGINEERING

2.1

Identify trends and issues

This section contains analysis of how the composition of those in engineering occupations has changed over the last 10 years and has changed in relation to the certain diversity characteristics. Due to data availability (and limitations relating to reliability) analysis of diversity is only possible by gender (women compared with men), by ethnicity (those with ethnic minority backgrounds compared with those with white backgrounds), and by disability (individuals classified as having a disability under the Equality Act 2010 compared with non-disabled individuals). However, it should be noted at this stage that these latter two groups are not homogenous groups and there may be differences by ethnic background or type of disability, but small sample sizes within the surveys do not allow us to explore with confidence the trends for different ethnic groups or for those with different types of disabilities. Furthermore, the survey sources look at sex rather than gender and so it is not possible to examine the characteristics of non-binary people in engineering. Finally, again due to the sample sizes, it is only possible to look at each of these dimensions in isolation rather than exploring combinations or intersectionality.

The analysis then explores the composition of those in managerial/professional and associate professional engineering occupations and whether these groups have become more diverse over time. In the final part of this section, we estimate how long it might take, in the absence of further steps being taken, to achieve representation within the engineering occupations that matches that in the wider population.

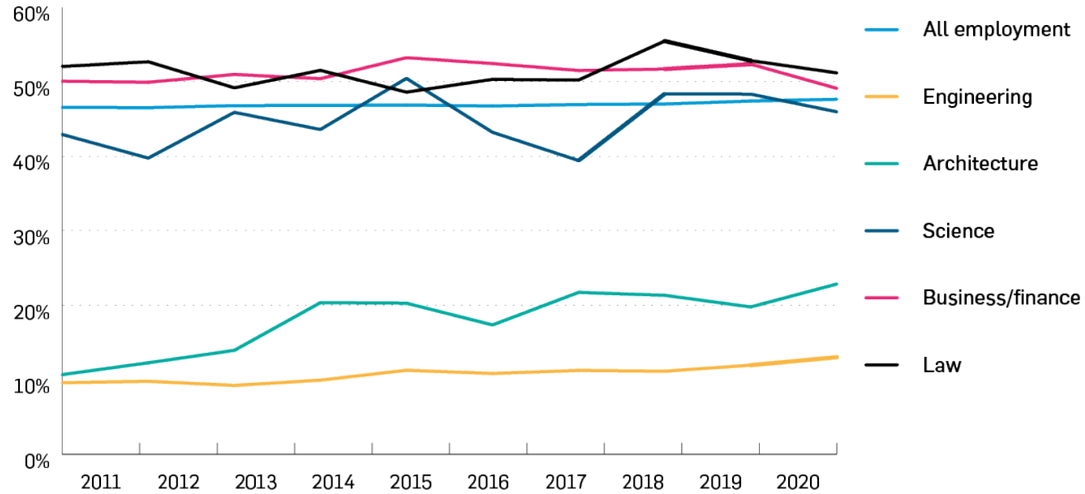
2.2

Women in engineering

Figure 2.1 shows that between 2011 and 2020, women made up on average 11% of those employed in engineering occupations. In 2020, the proportion of women in engineering occupations was, at 13%, around a quarter of the share of women in employment overall, of 47%. Engineering occupations have lower proportions of women in employment than all other comparator professions. Ten years ago, engineering occupations had a similar proportion of women compared with architecture, but since then the proportion of women in architecture has doubled, compared with a more modest rise in engineering. The share of women in science professions has fluctuated around the average proportion for the whole workforce, while law, and business and finance have had greater proportions of women than in employment overall, with broadly equal shares of women and men since 2011. There were 570 thousand women within engineering occupations in 2011, and this rose to 870k in 2020 (an increase of 52%), while the male workforce increased from 5.41 million to 5.81 million over this period (an increase of 8%).

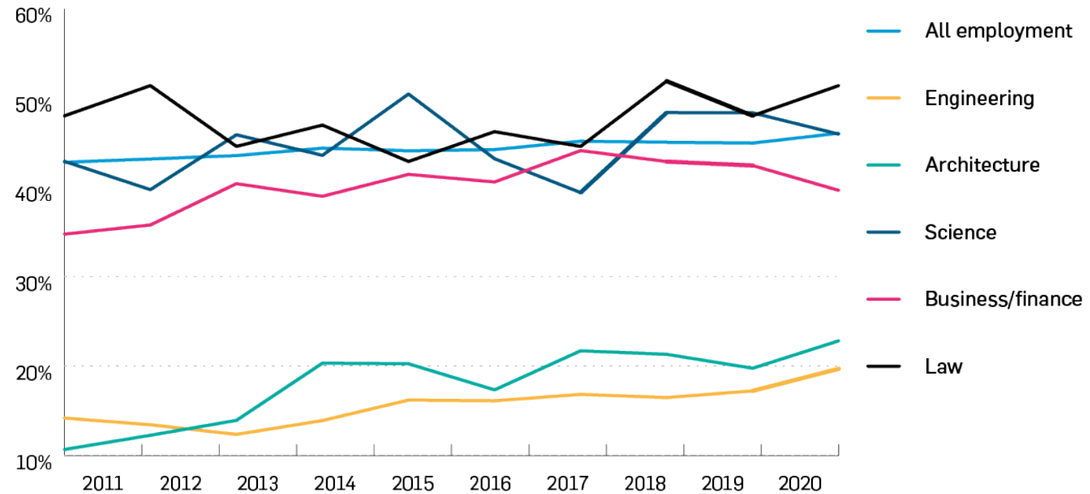
Using other definitions of engineering based around the engineering sector (which includes non-engineering occupations such as managerial, administrative and support roles), there is found to be a higher proportion of women than in engineering occupations, as women are over-represented in these non-engineering occupations within the sector. In 2020 around one in four workers in the engineering sector were female, almost double the proportion in engineering occupations.

Figure 2.1 Proportion of women in engineering and comparator professions



Source: Labour Force Survey, April to June quarters, 2011-2020

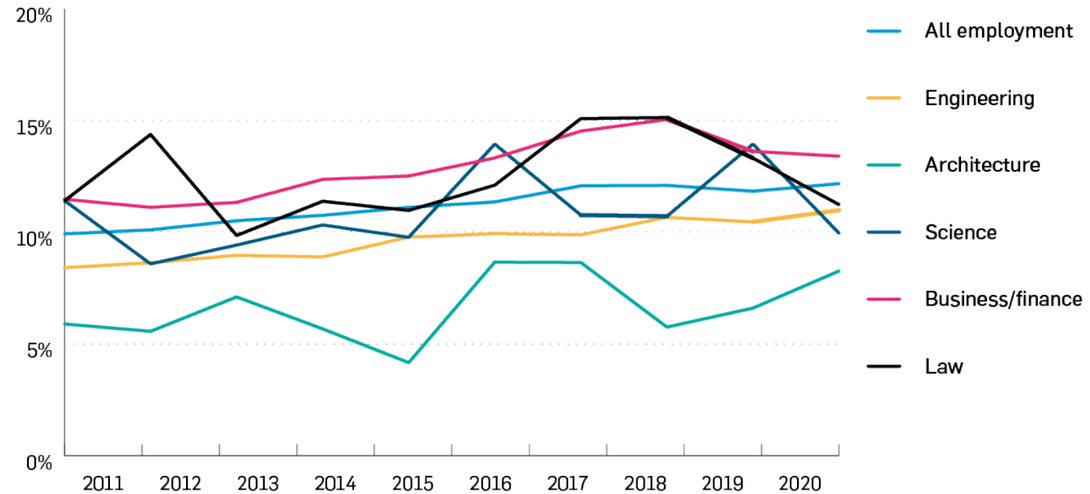
Figure 2.2 Proportion of women in managerial and professional occupations in engineering and comparator professions



Source: Labour Force Survey, April to June quarters, 2011-2020

Looking at the different occupational levels within the engineering profession, Figure 2.2 shows that in 2020 women made up one in five (20%) of those in managerial and professional engineering occupations, averaging 16% covering the period from 2011 and 2020. This represents the lowest share of women in managerial and professional occupations across the comparator professions, and was less than half the proportion of women in managerial and professional occupations overall in 2020 (46%). In comparison with other professions, the proportion of women in managerial and professional engineering occupations was most similar to architecture, which averaged 18% across the period, and was 23% in 2020. The proportion of women in managerial and professional occupations in business and finance has remained just below the proportion of women in managerial and professional occupations overall, while in law and science professions the proportion of women in managerial and professional occupations has fluctuated around the overall proportion. It should be noted Figure 2.2 disguises the large increase in the number (as opposed to the proportion) of women in managerial and professional engineering occupations, which has doubled from 250k in 2011 to 500k in 2020.

Figure 2.3 Proportion of ethnic minorities in engineering and comparator professions



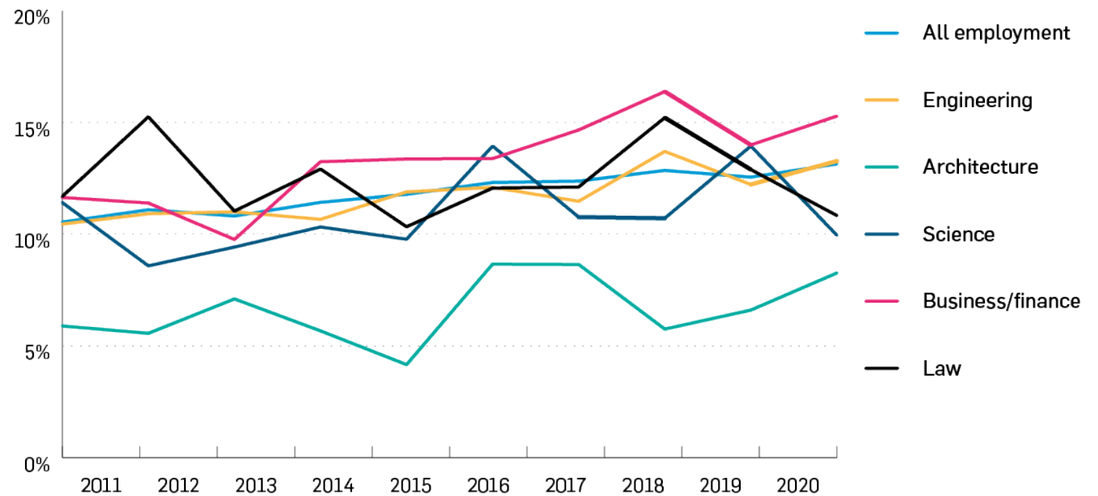
Source: Labour Force Survey, April to June quarters, 2011-2020

2.3

Ethnic minorities in engineering

Figure 2.3 shows that between 2011 and 2020, individuals from ethnic minority backgrounds made up on average 10% of those employed in engineering occupations. The proportion of ethnic minorities in all engineering occupations was broadly similar to that in the non-engineering science profession, which averaged 11% in the same period, and to the average proportion of ethnic minorities in employment overall, which was also 11%. Engineering had a higher proportion of workers from ethnic minority backgrounds than architecture, which averaged 7% across the last decade, but lower proportions than in law, and business and finance, which averaged 12% and 13% reflecting the increase in ethnic minorities in the population over this period.

Figure 2.4 Proportion of ethnic minorities in managerial and professional occupations in engineering and comparator professions



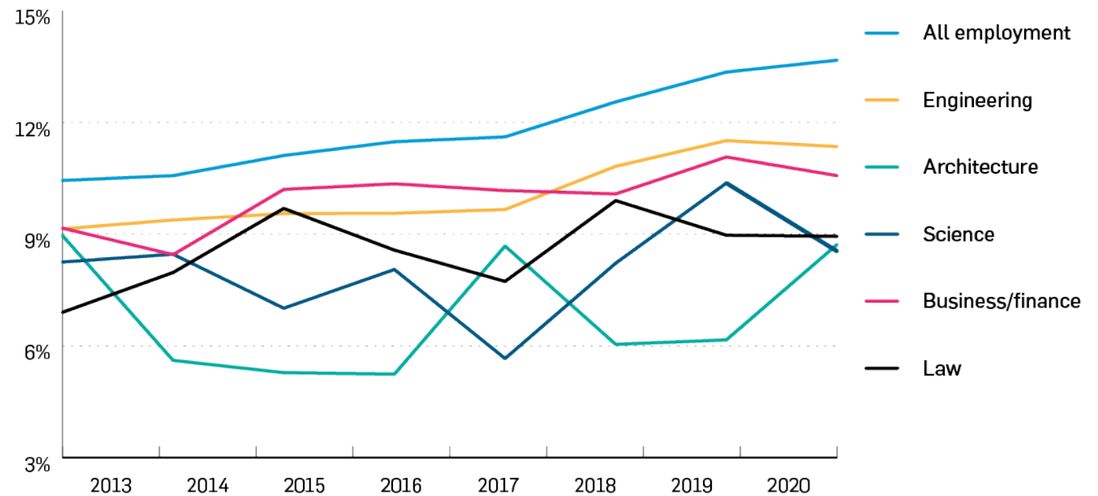
Source: Labour Force Survey, April to June quarters, 2011-2020

Figure 2.4 shows that from 2011 to 2020 the average proportion of individuals from ethnic minority backgrounds in managerial and professional engineering occupations was very similar to the average proportion of ethnic minorities in managerial and professional occupations overall. In 2020, 13% of those in managerial and professional engineering occupations were from an ethnic minority background, the same proportion as found for all managerial and professional workers. The trend in engineering was very similar to that in law, business and finance, and science over the last decade, with all professions having proportions of workers from ethnic minority backgrounds close to the average for the whole managerial and professional level workforce.

13%

of those in managerial and professional engineering occupations were from an ethnic minority background, the same proportion as found for all managerial and professional workers.

Figure 2.5 Proportion of disabled people in engineering and comparator professions



Source: Labour Force Survey, April to June quarters, 2013-2020

2.4 Those with disabilities in engineering

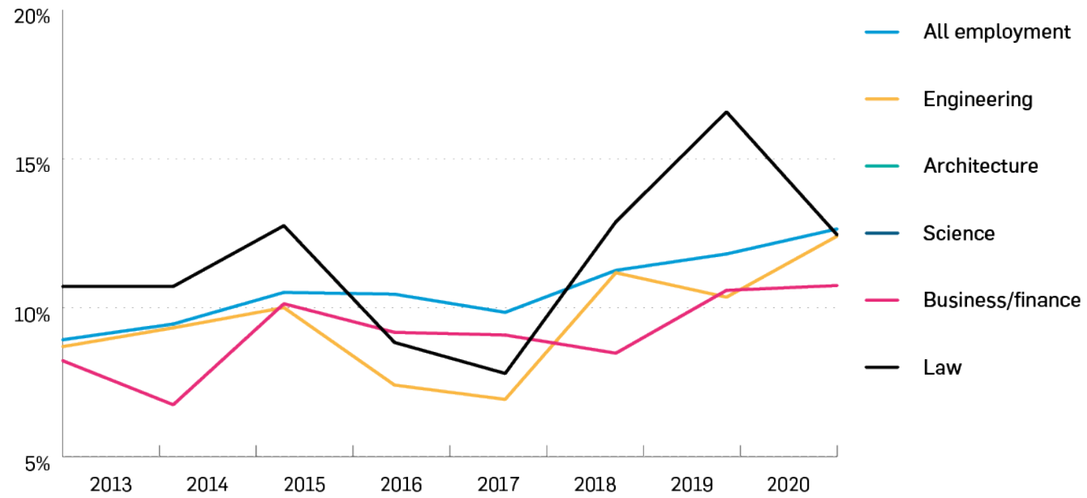
Figure 2.5 shows that between 2013[1] and 2020, disabled individuals who met the Equality Act definition made up on average 10% of those employed in engineering occupations, and this was the highest level in comparison with the other professions. In 2020, the proportion of disabled workers in engineering occupations was three percentage points less than the proportion of disabled individuals across all occupations (11% and 14% respectively).

The proportion in business and finance was just below that in engineering, while in law, science, and architecture the proportion was considerably lower, at 9%.

Based on the current rate of increase, by 2029 the proportion of Equality Act disabled people in employment in engineering occupations will reach the current proportion of Equality Act disabled people in employment of 14%. However, the overall proportion of disabled workers in employment is increasing at a faster rate than for engineering occupations, and so the proportion in engineering will never catch up with the overall rate, assuming rates of increase remain the same.

1 Prior to 2013 the Labour Force Survey used a different definition for disability, and so the data for 2011 to 2013 are not consistent with the data from 2013 onwards.

Figure 2.6 Proportion of disabled individuals in managerial and professional occupations in engineering and comparator professions



Source: Labour Force Survey, April to June quarters, 2013-2020

Figure 2.6 shows that between 2013 and 2020 the average proportion of disabled workers (using the Equality Act definition) in managerial and professional engineering occupations was 8%, two percentage points lower than the average proportion of disabled people in all managerial and professional occupations, but similar to the levels in law, business and finance, and science. In 2020, 10% of those in managerial and professional engineering occupations were disabled, compared with 11% found across all managerial and professional occupations.

10%

of those in managerial and professional engineering occupations were disabled, compared with 11% found across all managerial and professional occupations.

2.5

Projecting future changes in composition of engineering workforce

As part of our analysis we have estimated when, at the current rate of progress, the engineering profession will be a level playing field for all. This is a very inexact science given the data available, and the analysis here extrapolates the recent trends in the last decade to estimate when the proportion of women, people from ethnic minority backgrounds, and disabled individuals, in engineering would match that in the workforce as a whole, ***if nothing else changed***. Of course, future developments may impact the rate of progress, but this analysis provides a useful comparative benchmark of where the engineering profession is now and where it is likely to go if current trends continue.

The key points from this analysis are as follows:

Projections for women

- The current rate of increase in the proportion of women in engineering, of 0.36 percentage points per year, is inordinately slow and at this rate it would take nearly 100 years (estimated at 97 years) for the proportion of women in employment in engineering occupations to reach the current proportion of women in employment of 48% and a further 6 years to reach 50% of all workers in engineering occupations.
- Based on the current rate of increase in the proportion of women in managerial and professional roles in engineering, of 0.64 percentage points per year, it would not be until 2063 that the proportion of women in employment in managerial and professional engineering occupations would reach the current proportion of women in managerial and professional occupations of 46%.

Projections for workers from ethnic minority backgrounds

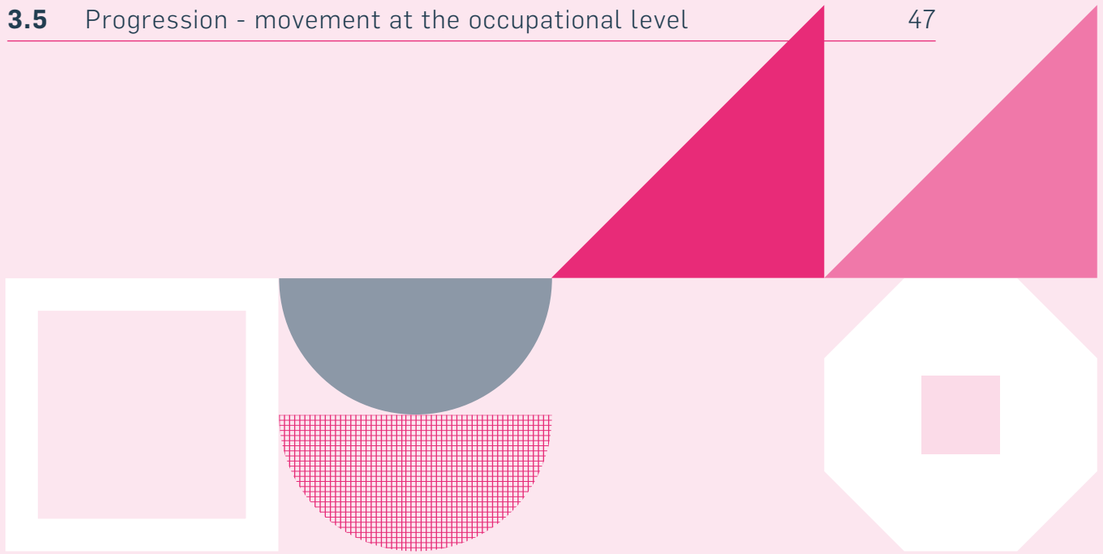
- Based on the current rate of increase (0.29 percentage points per year), by 2023 the proportion of those from ethnic minority backgrounds in employment in engineering occupations will reach the current proportion of ethnic minorities in employment, of 12%. However, the proportion of ethnic minority workers in total employment is also increasing, at 0.27 percentage points per year, and so the real rate of increase is very low. Were the current rates of increase to continue as they are it would take 50 years for the proportion in engineering occupations to catch up with the rising level in the overall proportion, at an estimated level of 24.5%.
- Looking at the ethnic profile of managerial and professional workers, the proportion of those from ethnic minority backgrounds in employment in managerial and professional engineering occupations matches the current proportion of ethnic minorities in employment in managerial and professional occupations overall of 13%, although as above this will need to continue to increase in line with population changes.

Projections for disabled workers (using the Equality Act definition)

- Based on the current rate of increase, by 2029 the proportion of disabled workers in engineering occupations will reach the current proportion of disabled individuals in employment of 14% (rate of increase of 0.36 percentage points per year).
- Based on the current rate of increase (0.36 percentage points per year), by 2023 the proportion of disabled people in employment in managerial and professional engineering occupations will reach the current proportion of disabled people in employment in all managerial and professional occupations of 11%.

03

ASSESSING THE INCIDENCE OF CAREER DEFLECTION



3.1

Identifying measures for career deflection

In the research we have highlighted four ways of identifying career deflection in engineering. The first is looking at retention rates in engineering and whether diversity groups leave engineering at different rates over time. Secondly, we look at progression through gaining managerial and supervisory responsibilities. Thirdly we investigate progression through increased rates of pay and finally looking at progression through changes in occupational level.

Two data sources have been used for the analysis of career deflection. The Labour Force Survey looks at changes from one year to the next[2], while Understanding Society allows us to track the same individuals over a 10-year period[3].

91%

Women working in engineering occupations had an annual retention rate of 91% in 2020, whereas for men it was 94%

3.2

Retention – remaining in and movement out of engineering

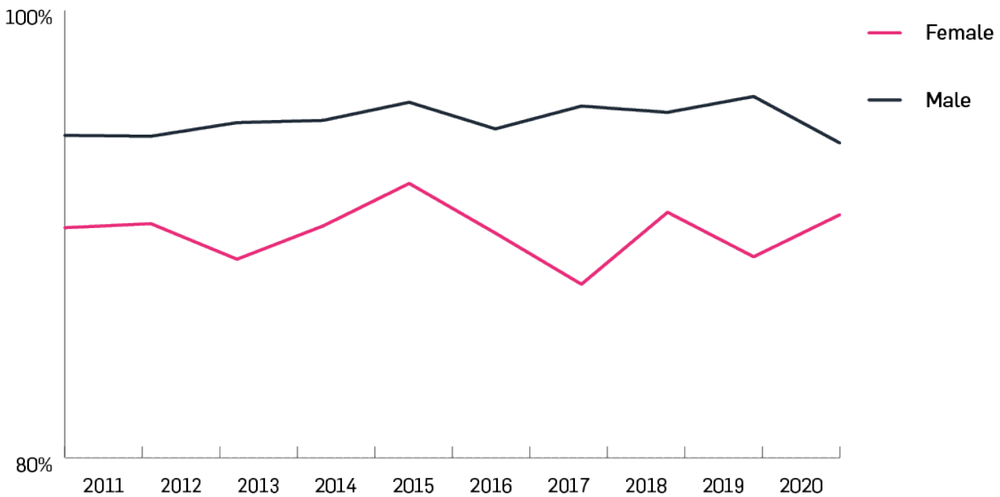
This section investigates retention in engineering, and outflows to other occupations, using flows analysis. The analysis shows whether those in diversity groups (that can be identified and tracked in the data sources) are more or less likely to leave engineering. Results are also shown for comparator occupational career pathways. This analysis covers those aged 20-49, as beyond this age group individuals may start to enter phased or early retirement which would not be considered as career deflection. That is not to say that workers aged 50 and over are not important for the engineering profession, but that those leaving the profession from the age of 50 may be doing so for positive personal reasons (pull factors) rather than as a result of career deflection (or push factors).

In these analyses, using the Labour Force Survey, a retained individual is defined as someone who was in the engineering profession one year ago and who is still in the engineering profession a year later – they may have changed employers, or were temporarily away from their jobs through sickness or maternity leave, but were classed as being employed in the engineering profession. Outflows to other occupations measures those who were in the engineering roles one year ago but who were working in another occupation one year later, and so excludes those who may take a career break and move into unemployment or inactivity (looking after home, studying etc).

2 Using the Labour Force Survey (LFS) it is only possible to observe retrospective questions on employment in the April-June quarters, therefore we have used a pooled 2011-2020 April to June dataset. Results which are presented for the LFS show comparisons between respondents' situation in the spring of the previous year, and their situation in the current year.

3 The primary analysis from Understanding Society focuses on those who were in wave one of the survey which took place in 2009-2011 and whether they are still in the engineering profession in wave ten (in 2018-2020). Analysis using Understanding Society however is limited due to small sample sizes.

Figure 3.1 Retention rate in engineering by gender by year



Source: Labour Force Survey, April to June quarters, 2011-2020

3.2.1 Retention of women from one year to the next

In engineering occupations, there has been a clear gender disparity in retention rates during the last decade (see Figure 3.1). Men working in engineering occupations had an annual retention rate of 94% in 2020, whereas for women it was 91%. The data show that 2.5m men (out of a total of 2.7m) remained in engineering occupations in 2020 from 2019, this compares to 420k (out of 470k) women over the same period. Since 2011 the year to year retention rate in engineering occupations has remained relatively constant for both men and women. The retention rate for men has ranged between 94% and 96% year on year whereas the retention rate for women has ranged between 87% and 91%. The average annual retention rate from 2011 to 2020 was five percentage points lower for women (90%) than men (95%).

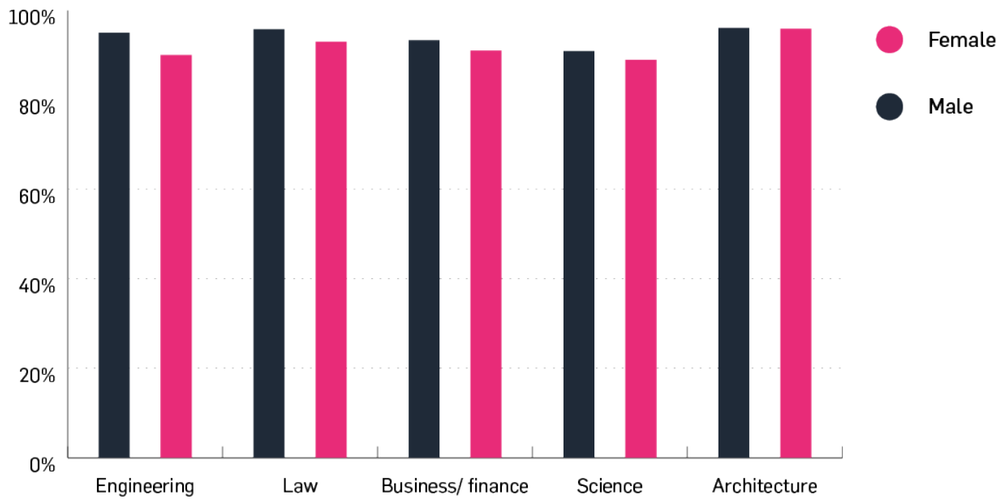
94%

The annual retention rate of men working in engineering occupations was 94% in 2020, compared to 91% of women in 2020

-5%

The average annual retention rate from 2011 to 2020 was five percentage points lower for women (90%) than men (95%)

Figure 3.2 Retention rate in engineering and comparator professions by gender



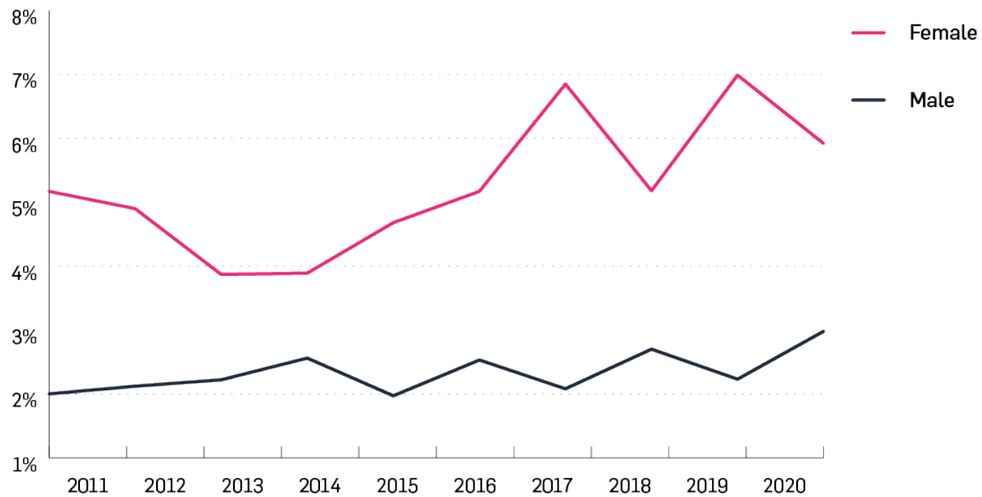
Source: Labour Force Survey, April to June quarters, 2011-2020

Figure 3.2 shows that the gender disparity in retention rates in engineering occupations is greater than in other occupational career pathways. Overall there was a five percentage point difference in retention rates between men and women in engineering over the period explored. The male engineering occupational retention rate was higher than found in business and finance, and science occupations, but lower than in law and architecture occupations. Average annual retention rates found for the last 10 years have been lower for women than men in law, business and finance, and science, but the gap has been notably smaller than in engineering.

Looking at the other comparator career pathways:

- Architecture had the highest retention rates, with no gender disparity (96% for males and females);
- Law had the second highest retention rates, after architecture, but it had the largest gender disparity amongst the comparator pathways, with the female retention rate being three percentage points below the male rate on average (93% and 96% respectively);
- The male retention rate in business and finance was below the rate in engineering (93%, compared with 95% in engineering) although the female retention rate was slightly higher than the rate in engineering (91%, compared with 90% in engineering); and
- The retention rates in science were the lowest of any of the comparator pathways, at 91% for males and 89% for females.

Figure 3.3 Rates of outflows to other occupations engineering by gender by year



Source: Labour Force Survey, April to June quarters, 2011-2020

Women leaving to another profession

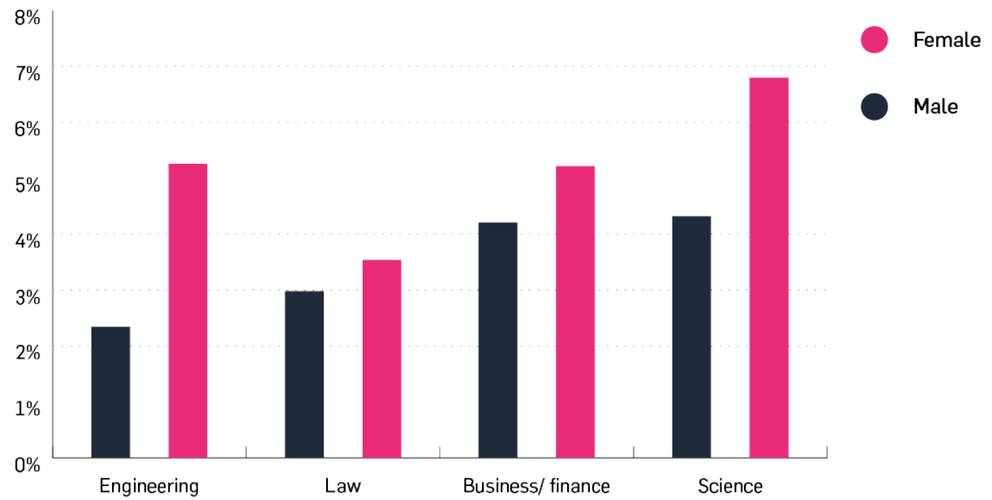
This analysis investigates a sub-group within engineers who are not retained from one year to the next, namely those who take up employment in other occupations, as these are more likely to be lost from the profession for ever than those moving into unemployment or inactivity, who may be taking short-term career breaks. Figure 3.3 shows that since 2011 the rates of workers leaving engineering occupations to work in other occupations has been much higher for women than for men, with slightly upward trends for both groups (but more so for women). The rate for men has ranged between 2% and 3% year on year whereas the rate for women has ranged between 4% and 7%.

Between 2011 and 2020 the average annual rate for leaving to other occupations was three percentage points higher for women (5%) than men (2%) year on year. In 2020, 80k men left engineering occupations for another occupation compared to 28k women, despite women making up less than one in five of those working in the engineering profession.

+3%

Between 2011 and 2020 the average annual rate for leaving to another sector was three percentage points higher for women (5%) than men (2%) year on year

Figure 3.4 Rates of outflow to other occupations from engineering and comparator professions by gender



Source: Labour Force Survey, April to June quarters, 2011-2020

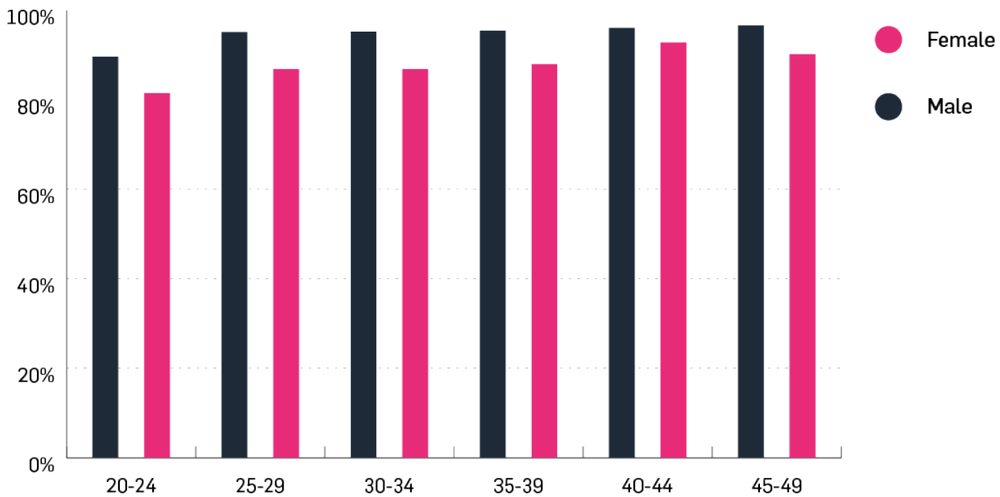
Figure 3.4 shows the disparity in outflow rates to other occupations between men and women between 2011 and 2020 for the comparator pathways (note that architecture is not presented here due to small sample sizes). Engineering had the lowest outflow rate for males at just over 2%, although the outflow rate for females was comparativley high at just over 5%.

Law had the second lowest outflow rate for males, and the lowest outflow rate for females, with the smallest gender disparity of less than one percentage point.

The outflow rates for men from business and finance, and science, were similar, at around 4%, while the female outflow rate in business and finance was the same as the rate in engineering (5%) and the female outflow rate in science was much higher than the rate in engineering, at 7%.

It should be remembered that this analysis looks at those moving to employment elsewhere, and those taking a career break for child rearing, childcare, or other reasons, and are not included in these outflow rates.

Figure 3.5 Retention rates in engineering by gender and 5-year age group



Source: Labour Force Survey, April to June quarters, 2018-2020

There is a clear disparity in annual retention rates in the engineering occupations between men and women over time, and Figure 3.5 investigates whether this is evident across all age groups. This uses data averaged over the last three years to provide an up-to-date picture whilst also averaging out any annual fluctuations.

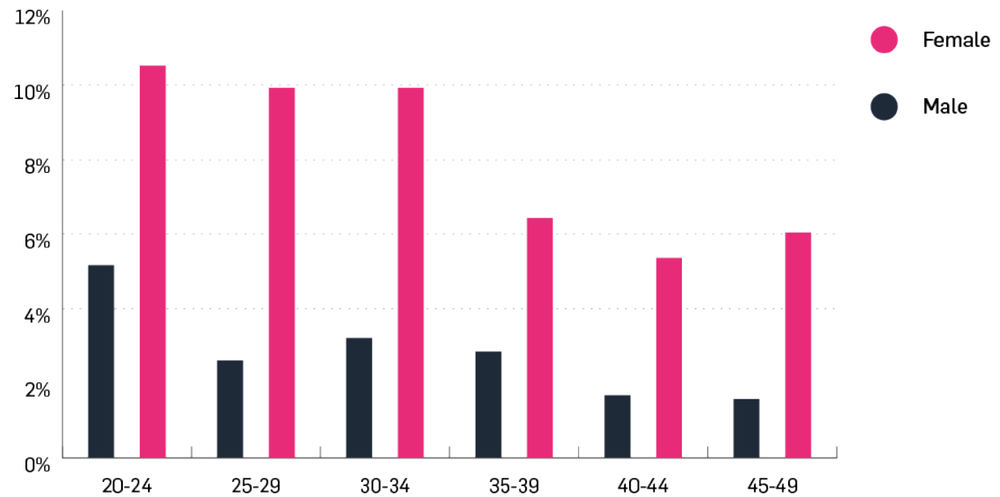
The retention rate for women aged 20-24 was just 82% compared to 90% for men. By the 25-29 years group for men the retention rate was 95%, whilst the retention rate for women was still lagging significantly behind at 87%.

There was still more than a five percentage point gap in retention by gender for both the 30-34 and 35-39 year old age groups. Only for the 40-44 year old age group could the retention rates by gender be seen to be broadly comparable. This shows that there are particular challenges in trying to keep 20-29 year old women in engineering occupations.

20-29yrs

There are particular challenges in trying to keep 20-29 year old women in engineering occupations

Figure 3.6 Rates of outflow to other occupations from engineering by gender and 5-year age group



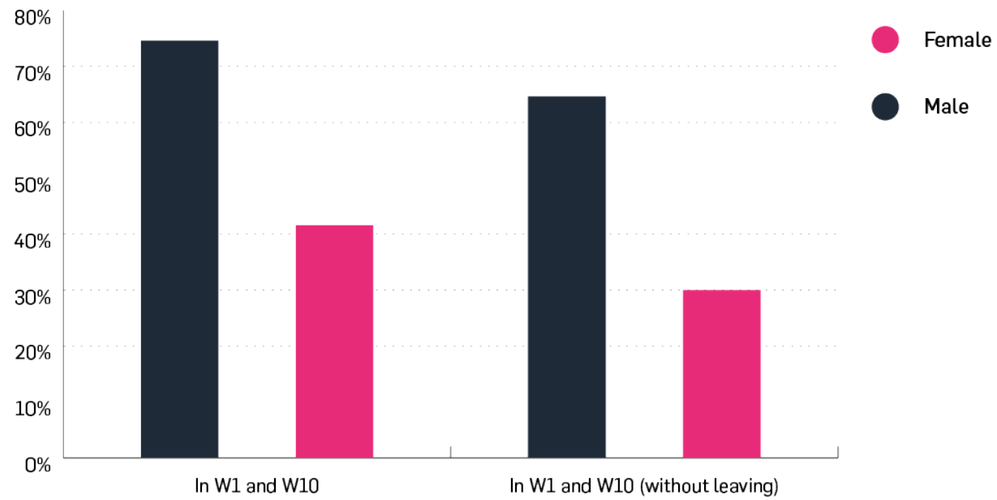
Source: Labour Force Survey, April to June quarters, 2018-2020

Figure 3.6 heavily supports Figure 3.5 in that there is a particular retention issue for young women in engineering occupations. This shows that around one in ten women aged between 20 and 34 will leave their role in an engineering occupation in the space of a year. The difference between the outflow rates for women and men is particularly pronounced for the 25-29 year old age group, where the outflow rate for men is particularly low; this is the age group in which people who have entered engineering occupations are likely to be trying to establish themselves in their careers. The data suggest that women in engineering occupations in this age group may find this harder than men, as their outflow rate to employment in other occupations is around four times higher.

3.2.2 Retention of women over the long term

As Understanding Society is a longitudinal data source, it is possible track the same individuals over a longer period of time. The following analysis presents the retention rate over a 10-year period within the engineering profession. Wave 1 of Understanding Society took place in 2009, this analysis shows the proportion who remain in engineering 10 years later (in wave 10).

Figure 3.7 Retention rates in engineering over 10 years by gender



Source: Understanding Society, W1-W10, 2009-2020

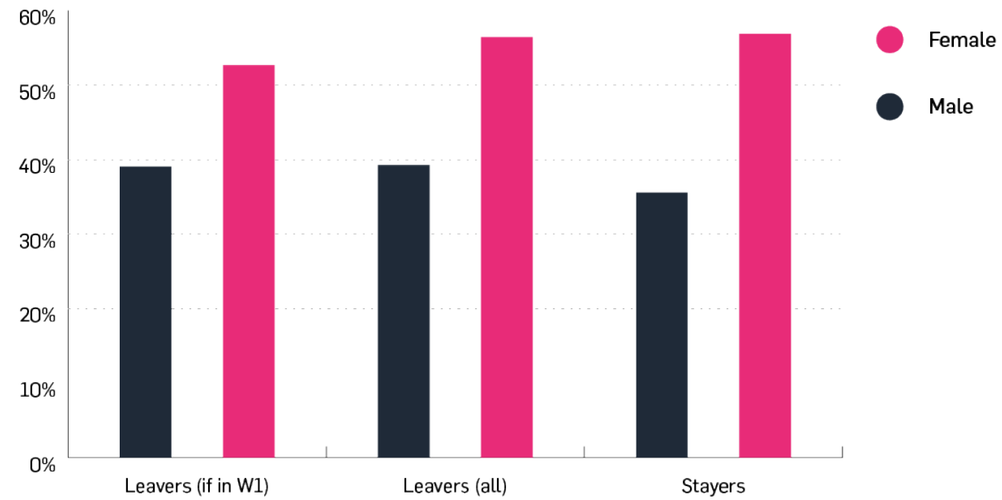
The left-hand cluster of Figure 3.7 shows proportion of those who were in engineering occupations in wave one who were also in it in wave ten but may have left at some point in between. It shows that men are significantly more likely to be in engineering occupations 10 years later, than women. Three quarters (75%) of men are in both wave one and wave ten compared to just 42% of women.

The right-hand cluster shows the proportion of those who have stayed in engineering at all waves and have not left at any point. Of those in wave one, 65% of men had a continuous presence in the engineering profession until wave ten, compared with just 30% of women.

As there was a distinct difference in retention rates between men and women further analysis was undertaken to explore the difference in characteristics between leavers and those who are retained in the profession by gender.

Qualifications: Overall females in engineering tend to have higher qualification levels on average than men, partly because they are less concentrated in the craft and operative end of the profession, and more concentrated in the graduate/professional roles. However, there is little difference in education levels between leavers and those who are retained within each gender, suggesting women have more transferable skills. Over half (53-56%) of female leavers had a degree or postgraduate qualification compared with 57% of women who were retained.

Figure 3.8 Degree qualified engineers by gender by leaving status



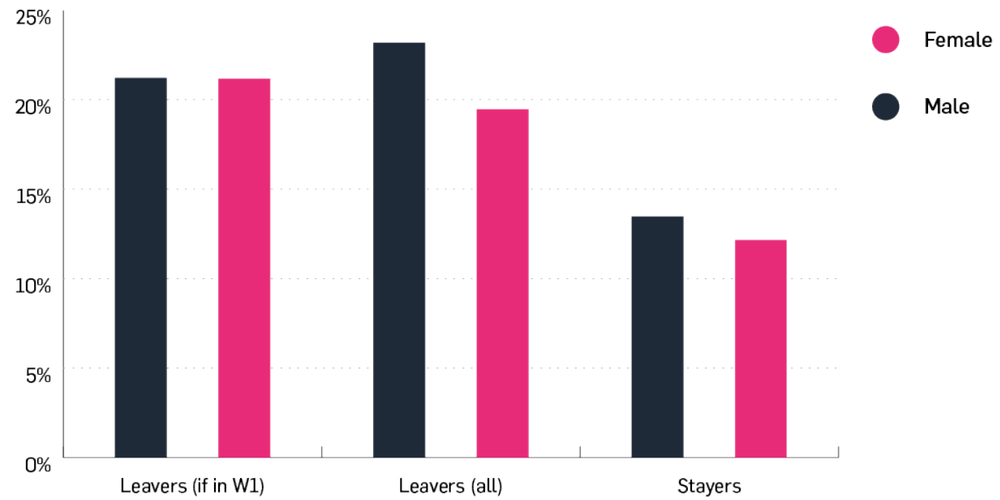
Source: Understanding Society, W1-W10, 2009-2020

Similarly, 39% of male leavers were qualified to degree level or above compared with 36% of males who were retained in engineering (see Figure 3.8). It is difficult to draw any firm conclusions from these small differences in the qualifications profiles of men and women who leave in comparison with those who are retained in the profession.

Pay: Analysis was also undertaken to explore differences by pay levels, although it should be borne in mind that these are highly correlated with qualification levels. However, the average rates of hourly pay for women were lower than men with little difference among those who were retained and those who left in the period before leaving. The average hourly pay for female leavers (if in the engineering profession in wave 1) was £14.84 compared to £14.78 among those who were retained. This is lower than the average hourly pay among male leavers (£18.02) and male stayers (£16.38).

Job satisfaction: In the period before leaving, leavers from engineering occupations were more dissatisfied with their job than those who were retained in the profession. This finding was evident for both men and women, with men being relatively more dissatisfied than women in the period before leaving (see Figure 3.9).

Figure 3.9 Level of job dissatisfaction in engineering roles in previous period by gender by leaving status



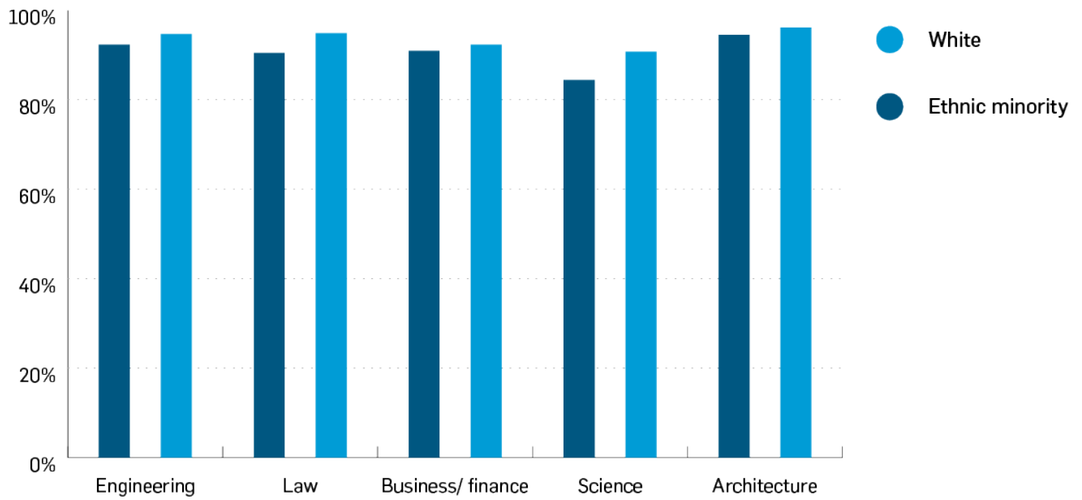
Source: Understanding Society, W1-W10, 2009-2020

Working hours: The average weekly working hours of women leavers from the engineering occupations were slightly lower than that of women who were retained in the profession, which may reflect a higher propensity to leave among part-time women than full-time women.

3.2.3 Ethnicity

Figure 3.10 shows there is a disparity in retention rate by ethnic group in engineering occupations, although compared with the other occupational career pathways the gap is relatively small. Overall there has been an average three percentage point difference in annual retention rate between those from white backgrounds and those from ethnic minority backgrounds in engineering over the period explored (95% and 92% respectively). However the gap has been shrinking over this 10 year period as there has been an upward trend in retention rates for ethnic minorities in engineering occupations.

Figure 3.10 Retention rate in engineering and comparator professions by ethnic group

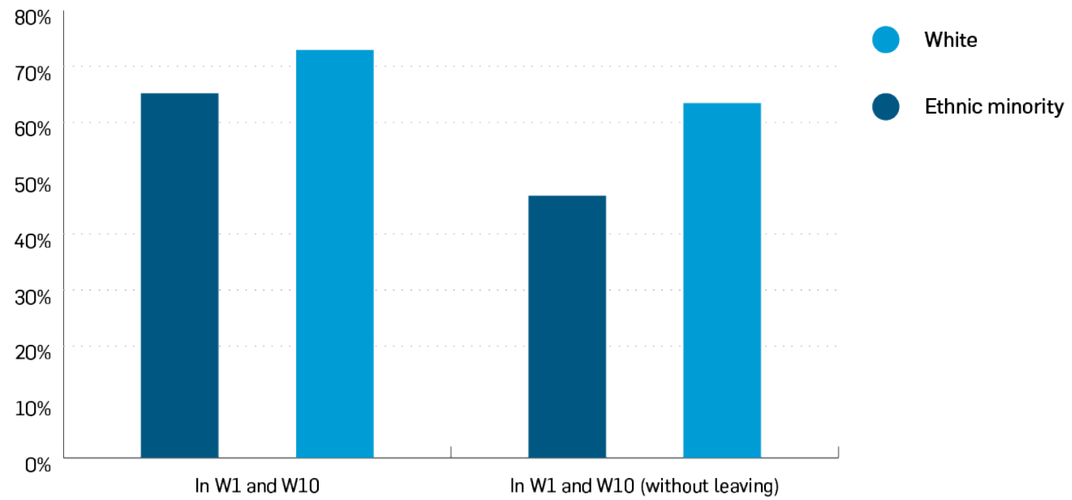


Source: Understanding Society, W1-W10, 2009-2020

In 2020 the retention rate for those with ethnic minority backgrounds in engineering was 94% compared to 93% for those from white backgrounds.

Comparing retention in engineering with other comparator career pathways shows that in all the comparator pathways the retention rate for workers from ethnic minority backgrounds was lower than that for white workers, with two occupations having a smaller disparity than in engineering (business and finance, and architecture) and two having a larger disparity (law and science). Retention rates for both groups were highest in architecture (96% for those from white backgrounds and 95% for those from ethnic minority backgrounds), and were lowest in science (91% for white workers and 84% for those from ethnic minority backgrounds).

Figure 3.11 Retention rates in engineering over 10 years by ethnic group



Source: Understanding Society, W1-W10, 2009-2020

The left-hand cluster of Figure 3.11 shows that those from a white ethnic background are slightly more likely to be in the engineering profession 10 years later, than those from an ethnic minority background. Seven in ten (71%) white employees in engineering occupations are in both wave one and wave ten compared to 65% of those from an ethnic minority background.

The right-hand cluster shows that of those in wave one, 63% of those with a white ethnic background had a continuous presence in the engineering until wave ten, compared to just 47% of those from an ethnic minority background.

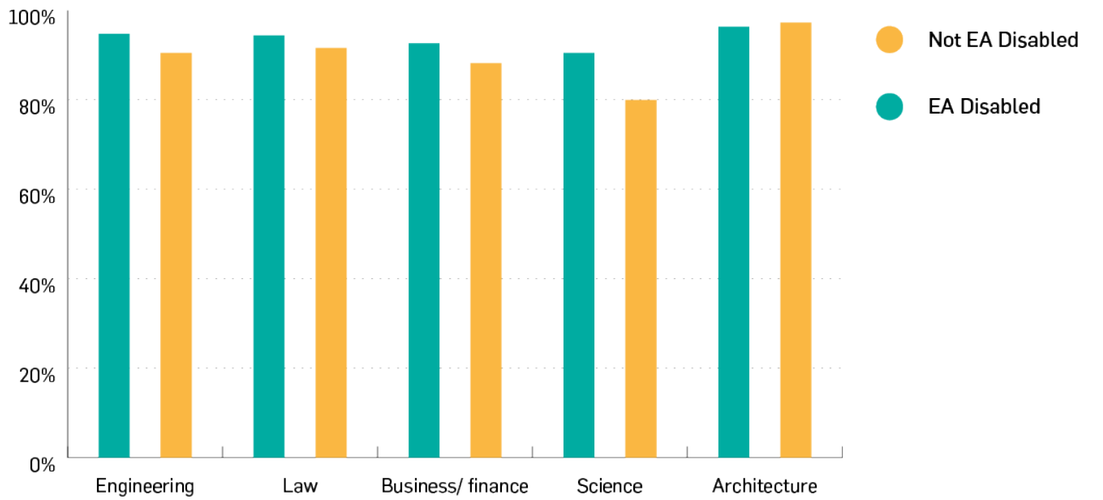
71%

of white employees in engineering occupations are in both wave one and wave ten compared to 65% of those from an ethnic minority background

63%

of those with a white ethnic background had a continuous presence in the engineering until wave ten, compared to just 47% of those from an ethnic minority background

Figure 3.12 Retention rate in engineering and comparator professions by disability



Source: Understanding Society, W1-W10, 2009-2020

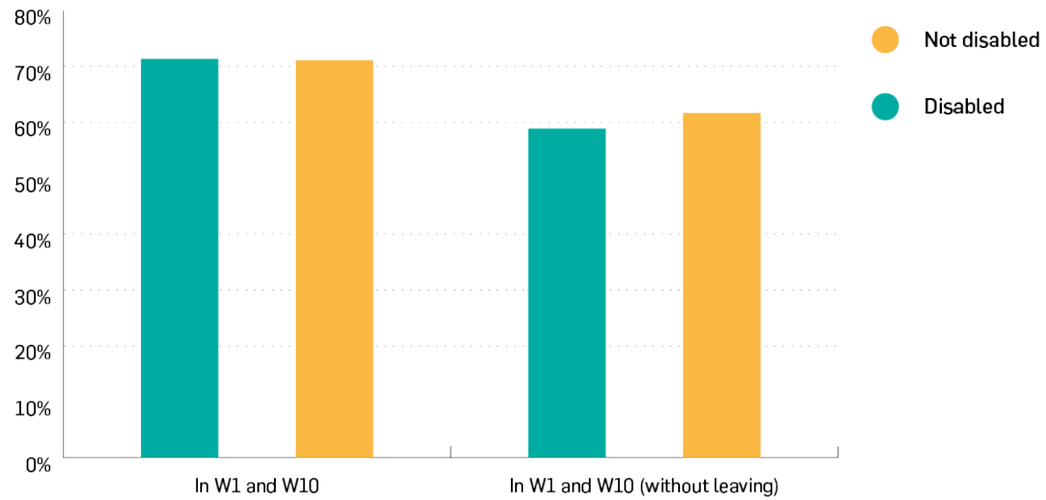
3.2.4 Disability

Figure 3.12 shows the disparity in retention rates of disabled workers and non-disabled workers (using the Equality Act definition) in engineering, in comparison with other professions. Overall there was a four percentage point difference in the retention rate between disabled and non-disabled individuals in engineering occupations over the period explored. The retention rate for disabled workers has ranged between 87% and 92% between 2013 and 2020 whereas the retention rate for non-disabled workers has ranged between 93% and 95%. However the gap between the two groups has been closing since 2013 as there has been an upward trend in retention rates for disabled workers in engineering occupations. In 2020 the retention rate for disabled individuals in engineering occupations was 92% compared with 93% for non-disabled individuals in engineering occupations

Among the other career pathways:

- The science occupational career pathways had the lowest retention rate for both groups across all the comparator pathways, at 80% for disabled workers and 91% for non- disabled workers.
- Architecture had the highest retention rates, and the rate for disabled workers was slightly higher than the rate for non-disabled workers.
- In law, the gap was smaller than in engineering, with the retention rate for disabled workers slightly higher than the rate in engineering, and the rate for non-disabled workers slightly lower than the rate in engineering; and
- The gap in retention rates between disabled and non-disabled workers was similar in business and finance to the rate in engineering, with retention rates for both groups slightly lower than the rates in engineering.

Figure 3.13 Retention rates in engineering over 10 years by disability

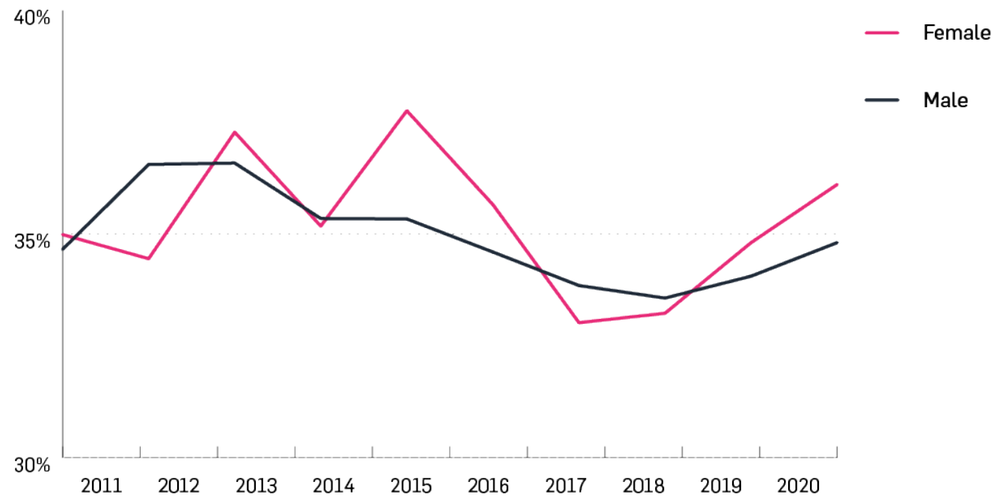


Source: Understanding Society, W1-W10, 2009-2020

The left-hand cluster of Figure 3.13 shows that there is little difference by disability status in the likelihood of being in the engineering profession 10 years later. Seven out of ten disabled and non-disabled workers in engineering occupations were in both wave one and wave ten. The right-hand cluster shows that of those in wave one, 62% of those without a disability had a continuous presence in engineering occupations until wave ten, and this compares with 59% with a disability.

This suggests that any barriers faced in engineering do not disproportionately affect disabled workers in comparison with non-disabled workers. But these aggregate patterns can mask retention issues for those with different disabilities and health conditions and those with intersecting diversity characteristics.

Figure 3.14 Level of managerial or supervisory responsibilities by gender



Source: Labour Force Survey, April to June quarters, 2011-2020

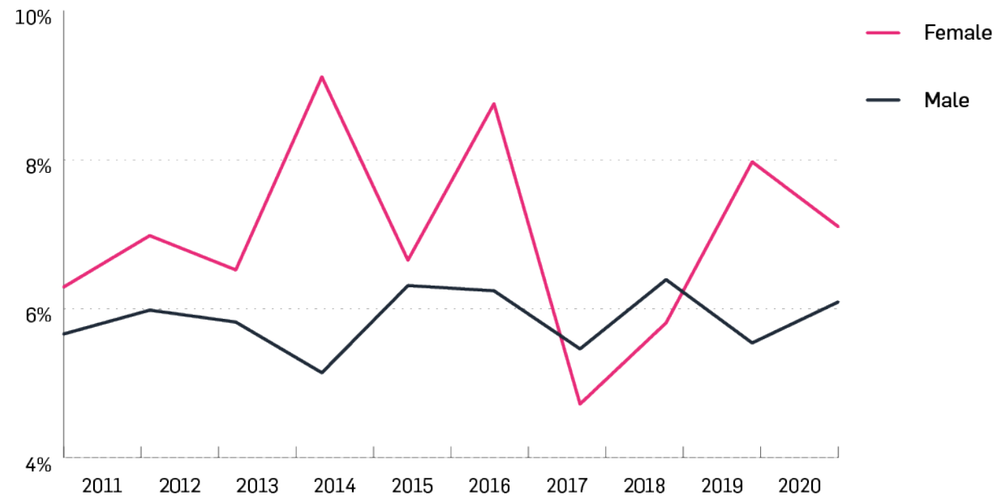
3.3

Progression – gaining managerial or supervisory responsibilities

The gaining of managerial or supervisory responsibilities can be considered an indicator of career progression, and the analysis here looks at the proportion of engineering workers, who did not have such responsibilities one year before, who now had them at the time of the survey. The analysis is undertaken for all ages.

Before considering those gaining managerial and supervisory responsibilities, we briefly look at the prevalence of these responsibilities among men and women in engineering roles. Figure 3.14 shows the proportion of workers in the engineering profession who had managerial and supervisory responsibilities, for men and for women. It shows that there was generally little difference in the proportion of those in engineering occupations who have these responsibilities by gender over time. In 2020 35% of men and 36% of women in engineering had managerial or supervisory responsibilities.

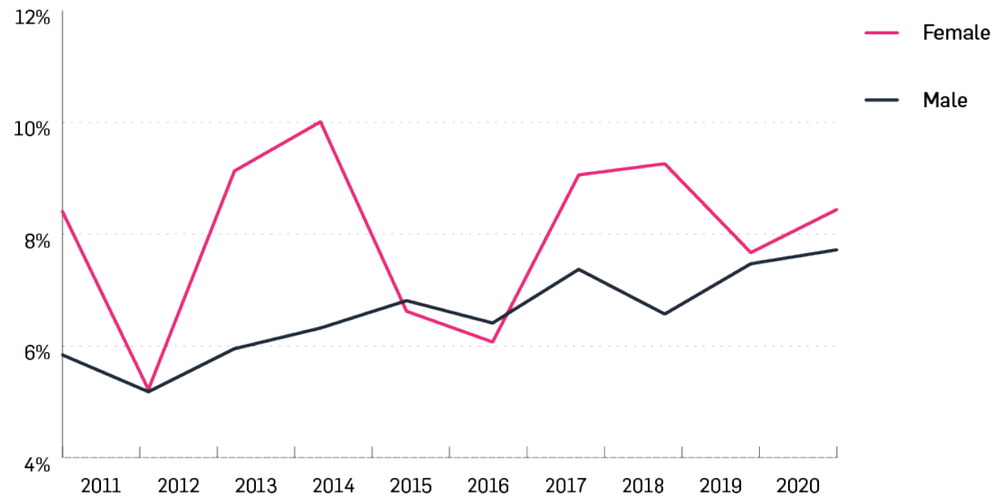
Figure 3.15 Inflows to managerial or supervisory responsibilities within engineering by gender



Source: Labour Force Survey, April to June quarters, 2011-2020

We now turn to the rates of those gaining such responsibilities from one year to the next, before looking at outflow rates, i.e. those losing these responsibilities. Figure 3.15 shows there is little difference in the rate females and males gain managerial or supervisory responsibilities in a year. In 2020, 6% of men and 7% of women without managerial or supervisory responsibilities a year before gained them, having worked in engineering occupations in both periods.

Figure 3.16 Outflows from managerial or supervisory responsibilities within engineering roles by gender

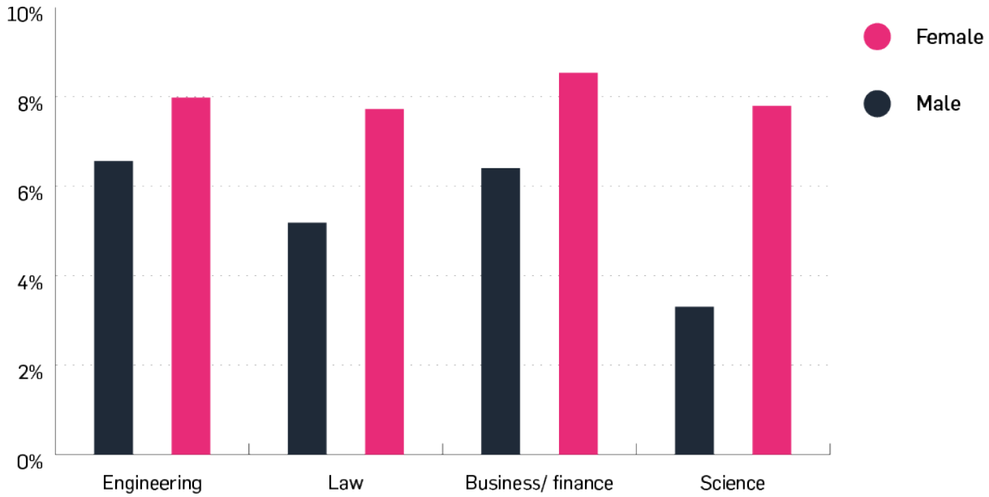


Source: Labour Force Survey, April to June quarters, 2011-2020

Over the last 10 years there is some evidence that outflow rates from managerial or supervisory responsibilities, that is individuals staying in engineering but ceasing to have managerial/ supervisory responsibilities, have generally been higher for women than men, as Figure 3.16 shows. The average outflow from managerial or supervisory responsibilities for men over the last 10 years had been 7%, the comparative figure for women was 8%.

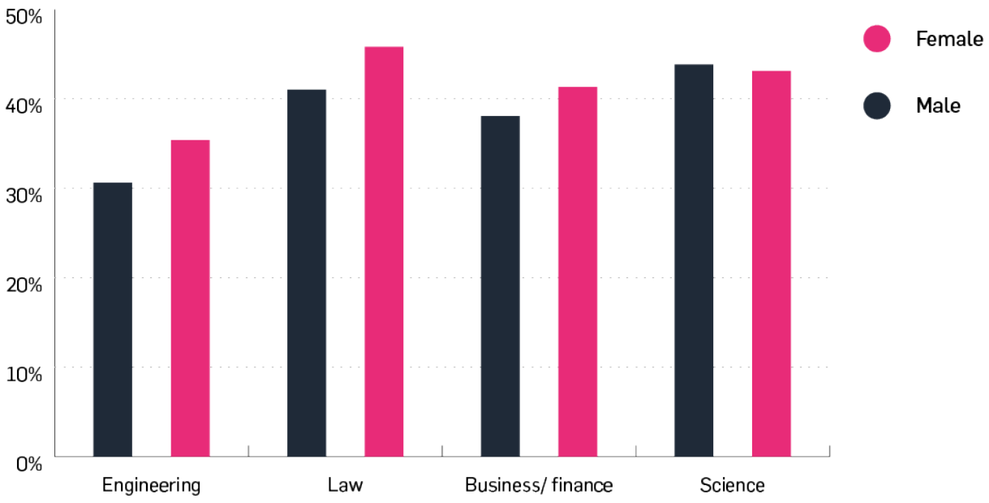
Losing these responsibilities may act as a barrier to progression in engineering occupations. However, this trend of higher outflows from managerial or supervisory responsibilities for women than men is also evident in other comparator occupational pathways as shown in Figure 3.17.

Figure 3.17 Outflows from managerial or supervisory responsibilities in engineering and comparator professions by gender



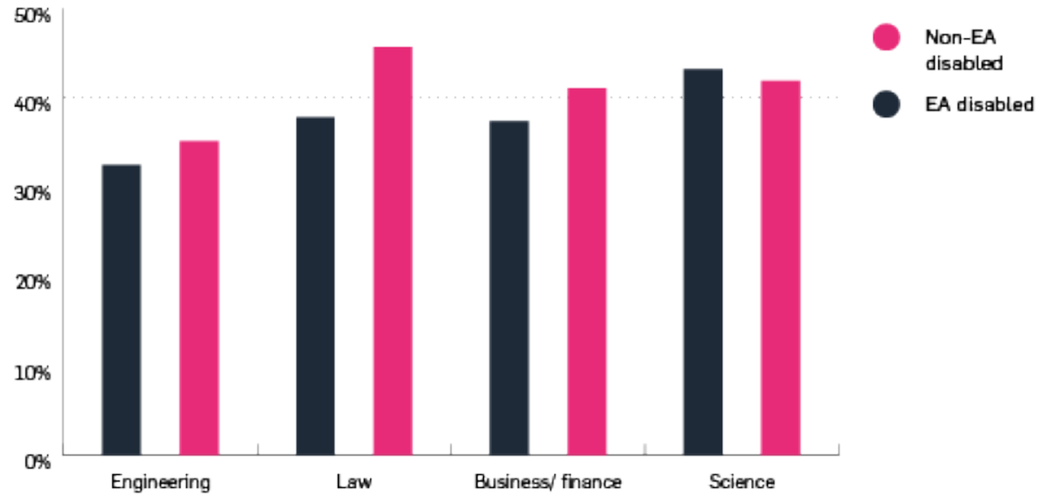
Source: Labour Force Survey, April to June quarters, 2011-2020

Figure 3.18 Level of managerial or supervisory responsibilities in engineering and comparator professions by ethnicity



Source: Labour Force Survey, April to June quarters, 2011-2020

Figure 3.19 Level of managerial or supervisory responsibilities in engineering and comparator professions by disability

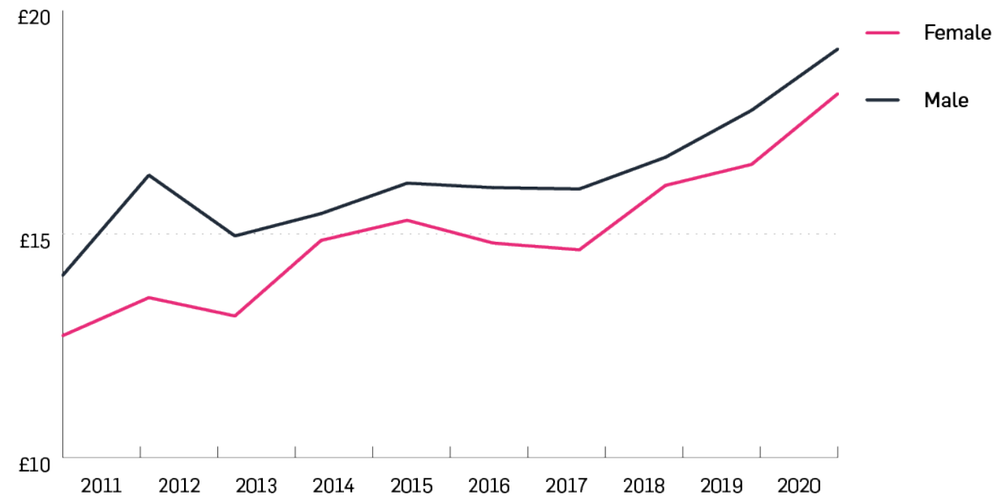


Source: Labour Force Survey, April to June quarters, 2011-2020

In summary, the level of managerial or supervisory responsibilities among men and women in engineering occupations is similar. Inflows to these types of responsibilities do not differ notably by gender (although it could be suggested that women inflow at a slightly higher rate). Women however do outflow at a slightly higher rate, and this is evident in many of the past 10 years. This disparity rate in outflows though is also evident in other professions, as seen in Figure 3.17. These results suggest there is similar access between men and women to these types of responsibilities which are associated with middle management.

Analysis of flows into managerial or supervisory responsibilities by ethnicity and disability in engineering occupations show little difference of rates (see Figure 3.18 and Figure 3.19). Despite little difference in inflows between those from white background and those from ethnic minority backgrounds in engineering occupations, there is a lack representation of ethnic minorities in managerial or supervisory responsibilities. This lack of representation is also evident in law occupations, but less so in business and finance roles.

Figure 3.20 Hourly pay for full time workers in engineering occupations by gender



Source: Labour Force Survey, April to June quarters, 2011-2020

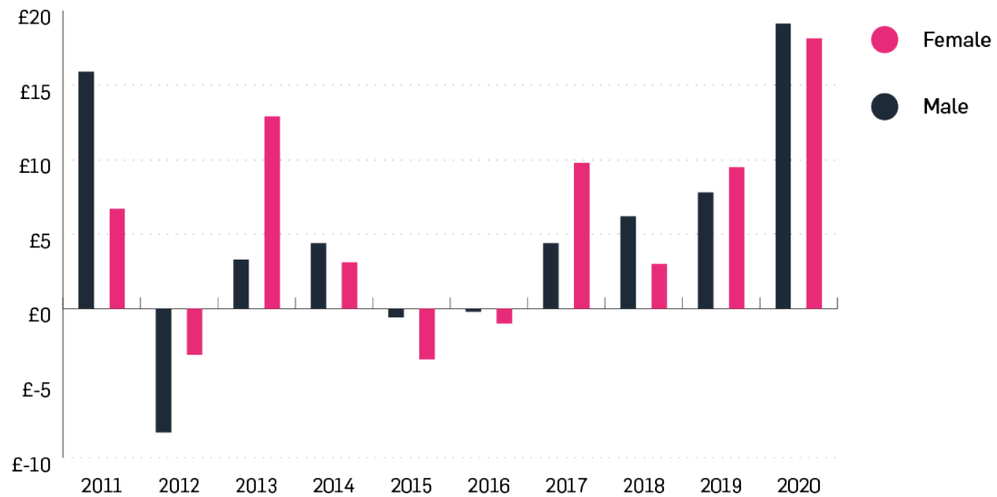
On average 31% of ethnic minority employees in engineering occupations have managerial or supervisory responsibilities compared with 35% of white employees in engineering occupations. The gap in levels of managerial or supervisory responsibilities is less pronounced between disabled and non- disabled individuals in engineering occupations (32% and 35% respectively). This contrasts to findings for other comparator occupations where, with the exception of those in science occupations, larger differentials exist.

3.4

Progression – change in pay

Another measure of career progression is increases in pay. From the LFS it is only possible to look at aggregate earnings data across groups in the workforce, rather than the changes in pay of individual workers. Additionally, sample size restrictions mean that this aggregate analysis is only possible for the whole engineering profession, and not broken down by occupational level within engineering as well as gender, ethnicity and disability. This is important to note as occupation level will have a strong influence on pay rates, and patterns for diversity groups may be driven by differences in occupation levels.

Figure 3.21 Annual increase in hourly pay for full time workers in engineering professions by gender

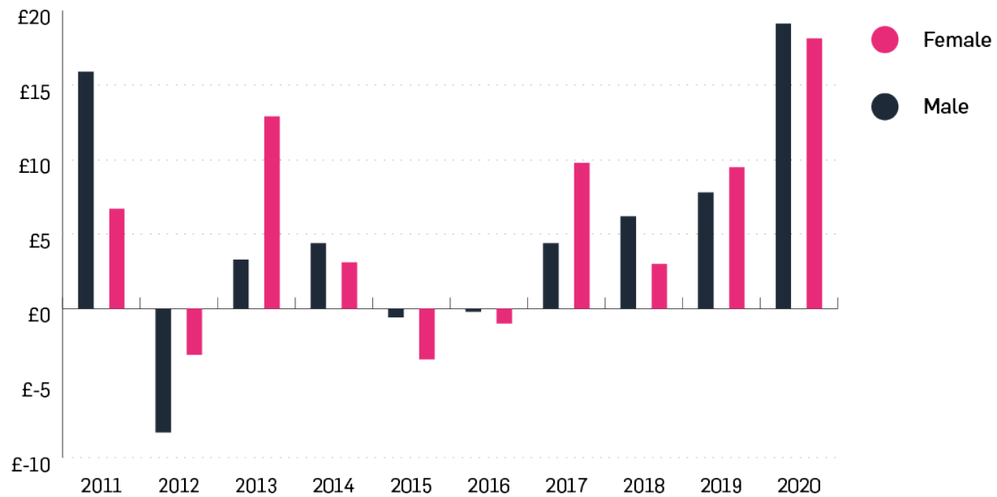


Source: Labour Force Survey, April to June quarters, 2011-2020

In all years since 2011 the average hourly pay for men working full time in engineering occupations has been higher than that for full time women, although women's pay has been catching up. In 2011 the average (full-time) hourly pay for men was £14.08 compared with £12.73 for women. In 2020 the respective figures were £19.14 and £18.14 (see Figure 3.20). However, the average annual increase in hourly pay for women is higher than that for men (see Figure 3.21). Over the past 10 years the trend in increases in hourly pay has been 50p/year for women and 40p/year for men. At this current rate of increase the average hourly pay will be equal between men and women in 2030.

Figure 3.21 shows the annual increases in hourly pay for men and women. The patterns vary from year to year, although larger increases in female pay in 2014 and 2018 contributed to female pay becoming 95% of male pay in 2020, up from 90% in 2011.

Figure 3.21 Annual increase in hourly pay for full time workers by gender



Source: Labour Force Survey, April to June quarters, 2011-2020

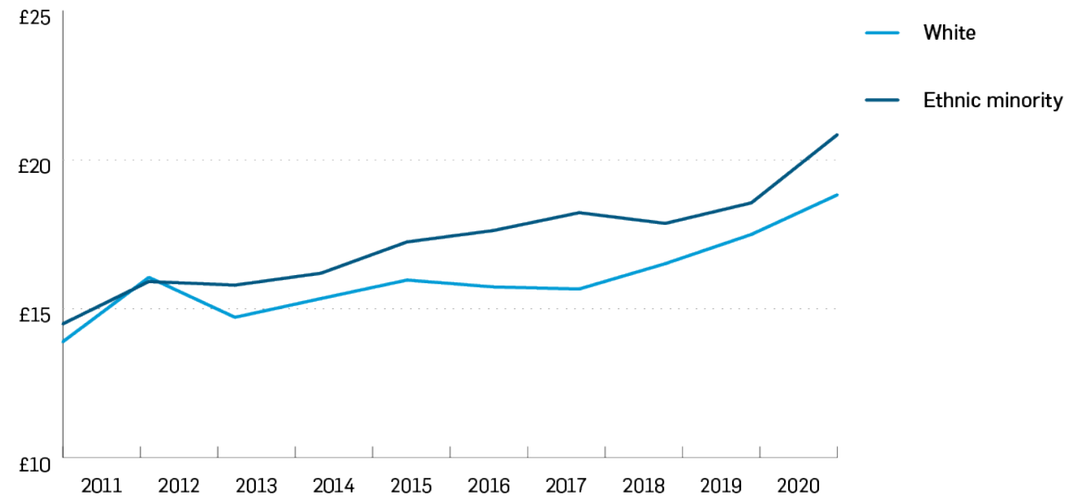
Average hourly pay for full time workers in engineering occupations from ethnic minority backgrounds was higher than for full time white workers in each year since 2013. In 2020 the average hourly pay for full time workers in engineering occupations with an ethnic minority background was £20.84 compared to £18.82 for those from a white background in engineering occupations (see Figure 3.22).

The LFS data show that among those in engineering occupations, as for many other professions, there is a pay gap between those who declare themselves as having a disability and those who do not. This pay gap is set to increase, as the trend rate of hourly pay increase among those in engineering occupations with disabilities was 39p/year compared with 53p/year for those who have not declared a disability. In 2020 the average hourly rate for disabled individuals was £15.82, much lower than the average hourly pay for non-disabled individuals which stood at £19.45 (see Figure 3.23).

£15.82

was the average hourly rate in 2020 for disabled individuals, much lower than the average hourly pay for non-disabled individuals (£19.45)

Figure 3.22 Hourly pay for full time workers in engineering occupations by ethnic group



Source: Labour Force Survey, April to June quarters, 2011-2020

3.5

Progression - movement at the occupational level

The definition used for occupational progression is a movement up the standard occupational classification hierarchy (SOC). However due to the nature of occupations in engineering it is very hard to change the level of occupation you undertake.

For example, a graduate engineer will be classed in the occupation classification hierarchy as an engineering professional (code 212), albeit an inexperienced one, rather than first appearing as a technician (associate professional level) and then progressing up to professional occupations.

Progression generally occurs within occupational levels, from junior/inexperienced to senior/experienced, rather than changing occupational categories. Likewise, a trainee engineering technician would have the same occupational code as a more senior technician colleague, because the activities they undertake in the role are very similar (according to the classification framework). Overall movements up the hierarchy total about 0.6% of workers each year, with no distinct differences by gender, ethnicity, or disability, therefore results are not presented here.

This limitation in the data highlights the importance of engineering employers undertaking tracking of career progression within their workforces.

04

UNDERSTANDING THE NATURE OF CAREER DEFLECTION

Understanding the nature of career deflection

To support the analysis of national data sources to identify the size and nature of career deflection (in terms of the lack of or lower rates of retention in engineering, progression to managerial responsibilities, pay increases and upward occupational movement) we undertook a brief exploratory search and review of the research literature around career deflection with particular attention paid to barriers to career progression and advancement in engineering faced by people with different backgrounds to understand how and why career deflection is experienced.

So here career deflection is defined as the lack of, or slower, career progress in all its guises, which can affect career journeys and ultimately retention.

The aim of the review was to provide evidence from other research to answer two key questions:

- Why are improvements to the diversity of engineering entrants not translating into long-term, successful careers for diverse groups?
- What are the factors that hold some back and propel others forward?

4.1

Nature and limitations of the evidence

There is a substantial literature on career choices, transitions from education to the labour market, and career entry of individuals and the recruitment and selection practices of employers. This literature focuses on understanding talent pathways and pipelines and challenges in reconciling the supply of and demand for skills in specific sectors and professions including engineering and challenges for increasing the diversity of supply. There is also a considerable body of statistical evidence on the lack of diversity in sectors including engineering, and also the benefits to organisations, industries and the economy of diverse workforces. However, our review primarily focuses on career progression, the next stage in the individual career journey.

The review highlights how there has been less attention paid to tracking individuals, particularly those from minority groups, once they are in employment and in an organisation; and less attention paid to understanding how careers do or do not progress, what facilitates and what hinders progression, and how this impacts on individuals and on retention.

We undertook a scan of academic literature and that produced by or for government, business or industry using bibliographic databases and a search of the publications and websites of key sector bodies. We prioritised materials published in the past five years (to capture the most recent research and discussions on this topic, and set within contemporary contexts), focused on engineering, set in the UK context and available online. We expanded our search where the evidence was particularly scarce, to include other related sectors, studies based in other countries and earlier studies. We also looked for research relating to the experiences of women, those from ethnic minorities, disabled people, LGBTQ+ individuals, and those from lower socio-economic backgrounds as these reflected the groups of particular concern for the engineering sector. These reflect but also expand upon the characteristics that were able to be explored in the data analysis (and presented in the preceding chapters).

We were able to identify over 70 studies focused on careers, barriers, and actions to support carrier development in engineering or related sectors and professions (and some papers covering a range of industries).

These studies tended to be small qualitative studies providing detailed insights into experiences of minority groups, although there were some larger survey-based studies and some studies including insights from employees in the majority group (to provide a comparison) and from managers and HR professionals. In the main, the research gathered perceptions of barriers experienced and reactions to these (including intending to leave the workplace, profession or sector) via interviews or self-report surveys rather than objective measures. We also identified a number of literature and evidence reviews which provided helpful summaries of key findings.

The greatest volume of the research literature identified was focused on the experiences of women. Women are a minority group in engineering, including in senior level roles, and facing the challenges that affect gender parity in the sector appears to be a difficult task for the UK (RAENG, 2018b) and other countries (Naismith et al, 2017, citing Fouad, 2014).

Our data analysis shows that although representation of women in engineering occupations and at senior levels is improving it is slow, and that women make up just 20% of senior roles which is lower than found in other comparator professions and found in the labour force as a whole (see section 2.2). Many of the issues uncovered in the literature for gender relate to other aspects of diversity and indeed some studies consciously attempt to explore intersectionality.

Intersectionality recognises that social categories are likely to be interconnected which creates overlapping and interdependent systems of discrimination or disadvantage. Thus experiences of individuals may not simply relate to ethnicity, gender, class, or sexuality but members of minority groups may be exposed to more disadvantage if they are 'subjected to multiple frameworks of oppression' (Crenshaw, 2017) or disadvantage can be compounded when identities converge for example as seen in the experiences of disabled women or women with LGBTQ+ identities (Lezotte, Hartman, Farrell and Forin, 2020; CRAC, 2020; CIPD, 2021).

The literature also stresses the importance of heterogeneity, and not viewing minority groups as one homogenous group of marginalised workers. For example, challenges faced by LGB+ workers, both in life, and in the workforce can fundamentally differ from those faced by their trans and non-binary counterparts, given that gender identities and sexuality are different (CIPD, 2021).

> The literature asserts that any attempt to understand barriers to progression and address imbalances should only be undertaken with the recognition that no individual is part of a homogenous group. Each person is an individual with many identity points that will impact them differentially and considering just one aspect of an individual's identity does not give a complete picture of their lived work experiences (EngineeringUK, 2018a; RAEng, 2018b; CIPD, 2021).

Given the volume and lengthy history of research covering gender it was possible to find examples of studies exploring women's experiences in engineering and in senior management although some of this research is based in other countries, as well as other (related) sectors including construction. Even in this large(r) body of work research on the professional development of women, and thus barriers to progression as well as advancement, has received little attention.

Our search highlighted a number of gaps in the literature:

Firstly, a lack of in-depth research examining engineering experiences of LGBTQ+ individuals, particularly in UK based contexts. Sexuality or sexual orientation and career progression has been less researched than other aspects of disadvantage (Barnard et al, 2020).

It is suggested that this may be in part driven by the fluid nature of sexual identity and that it can be concealed or non-visible. It is also argued that science and engineering (STEM) disciplines have particular issues when it comes to considering LGBTQ+ identities and discussion of LGBTQ+ inequality issues, as this may be perceived as threatening to the objectivity and depoliticised nature of these disciplines (Freeman, 2020; Cech and Waidzunas, 2021). We therefore broadened the scope of the search beyond the UK and to other sectors, and identified research in the USA which has explored challenges and barriers to progression faced by these individuals.

Secondly, it was challenging to find papers focused on the experiences of those from lower socio-economic groups. Socio-economic background is not one of the protected characteristics outlined in the Equality Act but is increasingly the focus of government attention and policy, particularly in terms of social mobility. Specific evidence of barriers to progression to date in this area is therefore limited and may need further and focused research. However, socio-economic background/social class often intersects with other minority identities and evidence of this was reviewed where possible/when available.

Thirdly, much of the evidence is drawn from qualitative methods which seeks to establish the lived experiences of the individual in the industry or occupation. Whilst this evidence is incredibly important, a theme within the research literature was the need for additional quantitative data collected across the employee life cycle.

This would support/supplement qualitative findings and would be beneficial particularly to provide statistical justification for new suggested interventions. Indeed, researchers noted how there is a lack of understanding of the size of the 'problem' due to difficulties collecting data in organisations about minority groups.

Fourthly, there appears to be a greater body of literature focused on the construction sector (and the UK is more prolific than other countries, Hasan, 2021) compared to the engineering sector, so to some extent the engineering sector is lagging behind. The volume of research in construction is however driven by a recognised and significant problem with equality, diversity and inclusion within the construction sector and the need to make improvements. Some of this literature explicitly includes engineering occupations/roles (professional and sometimes trade roles), and many of the findings will have resonance for the engineering sector.

It is important to recognise that although there are limitations in the evidence identified (including gaps) the existing research provides a strong basis for improving the understanding of career deflection for minority groups in engineering occupations, and suggestions for where further research could be focused.

4.2

How career deflection is experienced

4.2.1 Overview of career barriers

There have been a number of general studies which have sought to identify and categorise barriers to career related activities or to career decision-making (Swanson and Tokar, 1991; Hlophe, 2014; Lee et al, 2008) as well as those exploring specific sectors or occupations or experiences of specific groups which form the bulk of our review. A key tool in understanding this issue is the Career-Barriers Inventory (CBI and CBI-R) (Swanson and Tokar, 1991). This is a self-report questionnaire that was developed to explain concepts that might account for the gap between women's abilities and their achievements but is now being used with other diversity groups.

These highlight how barriers which make career progress difficult can:

- exist **within the person** and reflect internal conflicts ie intrapersonal including attitudes, personality traits, skills, qualifications, experiences and behaviours;
- exist **within their situation/environment** and reflect external frustrations including work, organisational practices, work environment and cultures, wider labour market demand, and wider socio-cultural environment relating to family, marriage and children, and what society considers are appropriate roles;
- and exist in **the interface between the internal and external** where these interact and relate to demographic characteristics, preparation for work, geographic mobility, lack of support structures and careers guidance.

The CBI-R identifies potential career barriers as:

- sex discrimination,
- lack of confidence (trust in one's own abilities or self-efficacy),
- multiple role conflict and conflict between children and career demands,
- racial discrimination,
- inadequate preparation (poor career planning),
- disapproval by (expectations of) significant others,
- decision-making difficulties (lack of clear career identity),
- dissatisfaction with career,
- discouraged from choosing non-traditional careers,
- disability/health conditions,
- job market constraints,
- difficulties with networking.

Holmes and Brown (2021) in their work for the CIPD looking at race inclusion argue that employers and HR professionals need to analyse and understand where barriers to career progression lie in their organisations and then use this information to enable people from any background or identity to reach their full potential at work. Their work involving a survey of over 2,000 UK employees (across a range of sectors) identifies career barriers as: skills and talents being overlooked, poor-quality line management, not being part of the 'in-group' and discrimination. Whereas career progression was perceived to be based on a mix of

internal and external factors: motivation to progress, availability of vacancies, employee's talents, visibility of employee's work within an organisation, strong work ethic, and networks and informal relationships.

4.2.2 Barriers in engineering (or related) sectors and professions

Research suggests that identifying types of career barriers experienced by different individuals can help in designing interventions (Lee et al, 2008). There were several barriers identified in the literature that were experienced by multiple minority or underrepresented groups. These are not mutually exclusive and often overlap. They appear as recurring themes and highlight areas for action.

Barriers are not static and can change over the life-course. They may differ according to role or level or even location in the organisation (Wiseman et al, 2013; Infante-Perea et al, 2018; Barnard et al, 2020; Wright, 2013). Barriers also differ by gender. Studies have found that women anticipate and face more barriers to progression and retention than their male peers and gender creates additional and specific barriers over and above other minority identities (Barnard et al, 2020; Fouad et al, 2019; Infante-Perea et al, 2018; Parnell et al, 2010).

The anticipation of barriers can lead to individuals selecting themselves out of certain industries and professions, in favour of more viable ones with few obstacles and more opportunities (Infante-Perea et al, 2018).

Stereotyping

This was a barrier experienced by women, individuals with disabilities, those from ethnic minorities, and those identifying as LGBTQ+.

Stereotyping – holding a fixed, over generalised image, idea or belief of a particular type of person – can lead to differentiated or **biased roles, biased task allocation** and restricted access to opportunities. Also stereotyping affects how those from minority groups in engineering which are traditionally male roles are viewed which can lead to **professional devaluation**. These mechanisms can create glass ceilings preventing progression.

Stereotypes can also be experienced very early on in individuals' lives and perpetuated in education which can create barriers to education choices and career choices (creating glass walls), as well as throughout the course of a career influencing retention within some fields (O'Connell and McKinnon, 2021; Lezotte et al, 2020).

Attitudes, behaviours, and perceptions were found to be the top barriers to women from all job roles and professions within the construction industry (Worrall et al., 2010). Research with engineers shows how, despite female engineers possessing the same skillsets and knowledge as their male peers, there are ongoing issues of women taking on roles in stereotypical gender functions such as office-based roles and in administration and support functions (Rimington, Metcalfe and Georgiadou, 2019). This can be found in other industries, particularly construction (Hassan et al., 2021; Worrall et al., 2010; Infante-Perea et al., 2018; Navarro-Astor et al., 2017).

Additionally, Garcia Johnson and Otto (2019) argue that task allocation is gendered and can keep gender minorities from career-development opportunities. Women receive less challenging tasks that are relevant for career development (eg restricted to smaller projects and lack of client contact, or boring, repetitive tasks where they are underutilised), are less likely to receive on-the-job training, and are more likely to be assigned and take on illegitimate tasks ie those perceived as unreasonable or unnecessary all of which act as barriers to progression (Garcia Johnson and Otto, 2019, citing De Pater et al, 2009 and Omansky et al, 2016; Hasan et al, 2021; Yonemura and Wilson, 2016).

Studies in related sectors show pervasive stereotypes where women are perceived as less capable than men, treated as less skilled than their colleagues and held to higher standards of productivity (Worrall et al., 2010) and not taken seriously, thus suffer from professional devaluation or double standards. This results in opportunities being taken away from women despite being interested and capable of accessing higher ranks. It also results in women not being judged on an equal playing field, albeit through sub-conscious bias (Rimington et al, 2019; O'Connell and McKinnon, 2012). Women feel they have to perform better, work twice as hard and work to prove themselves capable where their male colleagues would be assumed capable (Bryce et al, 2019; O'Connell and McKinnon, 2021; Worrall et al, 2010).

A specific issue for women is how stereotyping can lead to sexualised (in)visibility which also creates glass-ceilings. Fernando et al (2018) in their study of women engineers in the UK find that women in male dominated and highly masculine workplaces such as engineering are 'inscribed with sexual attributes that overshadow and obscure other attributes and values', and they call this 'sexualised visibility'. They argue that this means their interactions are scrutinised whilst at the same time their analytical and technical competence and leadership abilities and potential can be overlooked rendering them invisible in this respect and isolated.

To overcome stereotyping and gendered roles, women have acknowledged that they often have to downplay their feminine identity to try and fit into the industry (Naismith et al, 2017, p.231) or 'act like a guy' (O'Connell and McKinnon, 2021), or in essence, appear similar to the majority population of predominantly white, male engineers. Fernando et al (2018) term the former as 'avoidance' and the latter as 'assimilation', and find these tend to be used by women in mid to late career. These strategies can however reinforce stereotypes.

Alternatively, a strategy of enhancement, often used by women in their early careers, can offer greater possibilities for organisational change. Enhancement is where women seek to educate others about the positive attributes of their identity and work to advocate on behalf of women and challenge and defy stereotypes (Fernando et al, 2018). Lekchiri and Kamm (2020) also reported that women use various techniques to combat discrimination including: seeking social support, fighting back (not fitting in or by challenging discriminatory behaviour), and positive reappraisal (seeing discrimination as a challenge to prove individuals wrong).

Stereotyping also affects other minority groups in engineering. Minority ethnic engineers are more likely (85%) than their White (58%) colleagues to report that assumptions are made about them based on their ethnicity or nationality (RAEng, 2017b). Research in the USA finds LGBTQ+ individuals also experience professional devaluation and double standards in engineering and across STEM disciplines resulting from stereotyping, and suggests this is widespread (Cech and Rothwell, 2018; Cech and Waidzunas, 2021).

Dangers of unintended consequences

This was mainly discussed in relation to gender and LGBTQ+ identities.

There are concerns that some strategies used by women to manage stereotyping and discrimination in male dominated industries put the onus on women to change and can unwittingly reproduce and reinforce gender stereotypes particularly those which do not challenge the identity of 'serious engineering' or seek to challenge an inherently sexist system (Fernando et al, 2018; O'Connell and McKinnon, 2021).

There are concerns that the strategies adopted by organisations can also reinforce stereotypes or reinforce inequality. For example, strategies to increase women's access to managerial positions in male-dominated occupations such as engineering can promote sex segregation and reinforce stereotypes about women's suitability for technical work (moving them away from valuable technical roles to managerial roles). This can create gendered career paths (Cardador, 2017)[4]. Similarly, actions to address sexism at work can overlook other forms of discrimination such as heterosexism or conceal inequality (Garcia Johnson and Otto, 2019).

Garcia Johnson and Otto (2019) also warn of the dangers of tokenism, which can happen when a single person from a numerically underrepresented group is tokenised and expected to compensate for a lack of diversity of the whole organisation (citing Benschop and Doorewaard, 1998). This can create performance pressures, social isolation and role encapsulation. They also note other pitfalls such as glass or lavender (term used when faced by LGBTQ+ individuals) ceilings placing additional burdens on groups to reach leadership; and of the high risk of failure (citing Ryan and Haslam, 2005) where individuals from minority groups (often females) are appointed to leadership when the risks of failing are high.

Macho and hetero-normative cultures creating 'chilly' environments

This was a barrier identified in research with women and those identifying as LGBTQ+.

Domination of white heterosexual males across sectors such as engineering and construction, and particularly in senior roles, creates a particular macho culture. This is experienced as an 'old boys club', traditional management style and attachment to traditional values and 'chilly' work climate (Barnard et al, 2020; Yonemura and Wilson, 2016; RAEng, 2017b). This can marginalise or isolate individuals, push those from minority groups out of the industry, and can dilute or even negate the impact of equality policies.

4. It is interesting to note that the analysis presented in chapter 3 shows that men and women have similar rates of managerial and supervisory responsibilities and inflows to these types of responsibilities do not differ by gender, however women are more likely to outflow from these responsibilities.

Gendered differences in progression and particularly retention (a challenge highlighted in our data analysis section above) across industries including engineering has often been associated with hostile, isolating or chilly cultures (Jones, 2019; Yonemura and Wilson, 2016). Individuals from minority groups may face a dilemma in how they act within this culture. The culture can also deter those from already underrepresented groups from studying engineering or entering the industry thus perpetuating the problem.

Other dimensions to the macho culture of engineering and related sectors includes long-hours working and presenteeism, endurance of discomfort and self-sufficiency, discomfort in discussing personal issues, and rewarding of risk-taking (referred to in the literature as 'diving catch') and competition. This creates extreme pressure and job stress. Individuals may be penalised for risk aversion which is worsened by a lack of support network or penalised for seeking to balance work commitments with wider life commitments.

These create environments where women are not able to fulfil their potential (Yonemura and Wilson, 2016; Naismith et al, 2017). Some studies find that men too can experience the culture in engineering as hostile, but this is experienced in terms of overwhelming competition and inability to connect with colleagues (Yonemura and Wilson, 2016).

Hasan et al (2021) in their extensive review of the literature on women in construction (including those in engineering roles) note how the masculine work culture of the industry has remained a significant barrier to women's success. Similarly, Lan Oo et al (2019) in their small-scale study in Australia, also focused on women in construction, found barriers in early careers were perceived to be difficulty integrating into the masculine culture of the industry, stressful and competitive working culture, and long and inflexible working hours.

Naismith et al (2017) also conclude that the biggest hurdle for the construction and engineering industries in retaining women professionals and ensuring gender diversity within senior leadership is changing the culture so that males accept their female counterparts as equals. The challenge of hostility and the unwelcoming environment experienced when trying to make their way up the career ladder, along with gender discrimination, is also reflected in the work of Lekchiri and Kamm (2020) with women leaders in the US construction industry. The authors conclude that 'women in the US construction industry repeatedly operate in environments that do not satisfy the basic needs for them to succeed on the job due to deeply-rooted gender-biased organisational culture and the lack of support' (p591).

Research with LGBTQ+ individuals also find challenges faced can be a consequence of the culture of organisations and the implicit assumption of heterosexuality being the norm in the workplace (CIPD, 2021). These norms are arguably more prevalent in STEM professions such as engineering and construction, and in particular types of workplaces such as construction sites (Cech and Waidzunas, 2021; Barnard et al, 2020), and these are 'chilly' environments for LGBTQ+ individuals (TehQuin, 2020).

Research in the USA with students argues that 'LGBTQ+ inequality is part of the professional culture of engineering that pervades most engineering programmes' (Cech et al, 2017), and that LGBTQ STEM professionals were more likely to experience career limitations, harassment and professional devaluation than their peers, and were relatively more likely to intend to leave STEM disciplines and sectors including engineering (Cech and Waidzunas, 2021). LGBTQ+ employees can believe that they cannot bring their whole selves into the workplace and may subsequently try and adapt by presenting an ingenuine version of their self which can lead to negative outcomes including lower organisational commitment and failure to achieve personal career and life aspirations (CIPD, 2021).

Unchallenged discrimination and bias

This was a barrier discussed in relation to experiences of women, those identifying as LGBTQ+, and from ethnic minorities.

Research with LGBT workers (in construction) has identified instances of homophobia from clients and colleagues which is propagated by the hetero-normative culture in construction particularly on construction sites (Barnard et al, 2020) and that those in STEM fields identifying as LGBTQ experience harassment (Cech and Waidzunas, 2021). It is argued that the construction sector has been slow to broaden their equality, diversity and inclusion activities to include sexual orientation and so construction employers are less developed in their responses to homophobia which means it can go unchallenged (Wright, 2013).

Sexual orientation can be described as an invisible aspect of diversity and it is argued that sexual orientation and gender identity and gender reassignment are not accorded the same status as other equality strands by employers. This means that, even in good practice employers, individuals can experience uneven implementation of equality policies and may feel unable to challenge discriminatory attitudes and behaviours, especially in predominantly male work environments (Colgan, 2011).The research here is up to ten years old and so there may have been improvements (although no more recent studies were available).

Manifestations of discrimination, of sexism, heterosexism, and ableism, in organisations include harassment, microaggressions (eg insults, invalidations), and disguised forms such as higher rates of bullying. These can happen in both male and female dominated workplaces. These can be enabled or moderated by the organisational culture embodied in its shared norms and values, by perceptions of appropriateness of behaviours and attitudes, and by policy and politics reflecting the power dynamics of organisations.

Exposure to discrimination and harassment affects wellbeing and physical health; and also job satisfaction, engagement, commitment, performance and withdrawal (Garcia Johnson and Otto, 2019; Yonemura and Wilson, 2016).

The research asserts there is a complacency among the majority, the dominant group of white able-bodied males in engineering, and a lack of awareness of barriers to inclusion, the role they as the dominant group play in perpetuating cultures and that change is needed to allow inclusive cultures to be formed (RAEng, 2017b). This can allow for discrimination and bias to go un-checked.

Active involvement of those in the majority is necessary, and they must look to improve and behave as allies to their colleagues in ethnic minority groups and be equipped to have conversations about race and ethnicity (CIPD, 2021; RAEng, 2017b; McBride-Wright, 2020).

Flexibility requirements and family commitments

This was a barrier primarily experienced by or discussed in relation to women.

The research literature identifies that the engineering industry does not accommodate women who are considering starting, or have already started, a family and may need alternative models of working and/or reduced hours. The industry does not allow individuals to balance family commitments with work or offer a good work/life balance more generally. This affects decisions about careers in engineering and thus supply of new entrants (Papafilippou and Bentley, 2017), and experiences of those in the industry particularly those returning or considering returning to work post-maternity and considering staying in engineering once they have a family (Fouad et al, 2019; Fouad et al, 2011; RAEng, 2018b).

The most significant barriers to women's career advancement are regarded to arise from a conflict between external responsibilities and caring responsibilities and with current models of working which involve norms of overwork, expectations of constant availability, excessive workloads, requirement for geographic mobility and unpredictable work demands.

This is exacerbated by alternative ways of working not offering parity due to a shortage of quality part-time work and little returns to the part-time experience or opportunities to progress (Jones, 2019). Women face an additional biological burden, often being pushed to choose between having children or a career (O'Connell and McKinnon, 2021).

A study by the Royal Academy of Engineering found that 60% of women in STEM who had taken a maternity or career break reported that they felt their return to work was hindered or prevented by a variety of barriers, such as the cost of childcare (52%) and a lack of flexibility in working patterns (27%) (RAEng, 2018b).The issue lies with a culture of long hours working, stressful work environment and negative attitudes towards work/life balance (Bryce et al, 2019; also Lekchiri and Kamm, 2020; Hasan et al, 2021) and towards breaks in service and part-time and flexible working arrangements (Jones, 2019).

A study in Australia found female engineers typically worked 55 to 65 hours a week and this was a key reason for them leaving or considering leaving the industry, and could explain the low proportion of mothers in the industry (Bryce et al, 2019). This links with the findings of the data analysis presented above highlighting the lower retention rates and higher outflow rates to other professions of women in engineering occupations

(particularly under the age of 40) compared their male peers; and the relatively much small proportion of women found to have worked continuously in engineering roles across a ten-year period.

Reducing working hours negatively impacts upon career progression. Women in engineering who reduce hours on returning to work post-maternity leave often face a progression penalty as a result of not working full time such as missing out on career opportunities (RAEng, 2020; Bryce et al, 2019; Naismith et al, 2017). Research with female engineers in the construction industry in Australia found those who had returned to work after having a child(ren) rarely held a job requiring more knowledge and skill than their previous position (Bryce et al, 2019).

These issues are also found in the construction industry (Navarro-Astor et al, 2017; Hasan et al, 2021), for women in academia in STEM disciplines (O'Connell and McKinnon, 2021) and women in the defence industry (Rimington et al, 2019). In a study focused on the UK defence industry, requests by female employees for flexible working practices or to work from home were seen as making a conscious choice that affected their work. Whereas in contrast, men who asked to work from home were assumed to need additional space to be able to concentrate and hence produce more work (Rimington et al, 2019).

Lack of career resources and opportunities

This was a barrier was largely discussed in relation to women and those identifying as LGBTQ+.

Across all employees a lack of careers guidance particularly among those in their 40s and 50s, can be a barrier to progression (Wiseman et al, 2013). Lack of transparent career pathways can also be a barrier.

Work with early career female engineers in the USA finds they encounter mysterious career pathways, where individuals feel unable to move forward in their career often through repetitive and unrewarding work and a lack of recognition (Yonemura and Wilson, 2016). Similarly qualitative research with female engineers in the UK finds that most pointed to a lack of transparency around progression opportunities as a reason for not finding themselves in better paid roles (RAEng, 2018a).

Opportunities, support and information around career progression in engineering can be difficult to find (RAEng, 2017b). The perceived lack of transparency around hiring and promotion procedures is evident in similar industries, such as the UK defense industry (Rimington et al, 2019).

Additionally, a lack of formal training and lack of relevant experience and thus access to the career enhancing opportunities can be barrier for minority groups. This closely relates to biased task allocation. Employers argue that the construction industry is 'experience driven' with demonstrating competence/proven experience as the most critical factor in external recruitment and internal advancement (Wiseman et al, 2013, looking at construction in the UK).

A large-scale quantitative study in the USA undertaken by Cech and Waidzunas (2021) involving a survey of more than 25,000 full-time employed STEM professionals, including over 1,000 individuals identifying as LGBTQ, explored potential inequalities along a number of dimensions including career opportunities. This study found LGBTQ STEM professionals (holding constant demographic, discipline and job-related factors) were significantly less likely to report they had opportunities to develop their skills and to report they had access to the resources they needed to do their jobs well than their non-LGBTQ peers.

Lack of role models

This was a barrier experienced by women, individuals with disabilities, those from ethnic minorities, and those identifying as LGBTQ+.

Research highlights a distinct lack of women, ethnic minorities those identifying as LGBTQ+ and disabled people in engineering at senior levels (RAEng, 2018b; Ethnic Dimension, 2014; Bryce et al, 2019; Lekchiri and Kamm, 2020; Lezotte et al, 2020; Colgan, 2011).

A study of female engineers in construction in Australia found that women who tended to work in male dominated workplaces, had never had a female (engineering) manager, and did not have a senior female role model at work in whom they could seek guidance (Bryce et al, 2019).

Role models are important in indicating possibilities within organisations for those in the sector and can act as guides or mentors, so the shortage of role models can act as a barrier to mentoring of minority groups (Hasan et al, 2021).

Role models are also important in recruitment of minorities to the sector. The perception of engineering as a possible career is influenced by the way female and disabled people's experiences in the industry are communicated, indicating that role models, or more importantly visible and vocal role models are vitally important (RAEng, 2018b; Brewster et al, 2017). Role models and encouragement in childhood and during education are also important as they can help to establish a sense of career identity (Papafilippou and Bentley, 2017; Naismith, Robertson and Tookey, 2017).

The data analysis presented above indicates that women are significantly underrepresented in engineering at all levels including senior roles and, although ethnic minorities and disabled individuals are not proportionally underrepresented in engineering or senior roles, there are by volume few individuals in senior roles from ethnic minority backgrounds or with disabilities. This suggests a potential shortage of role models for those from diverse backgrounds.

Isolation and the lack of support, mentoring and networks

This was a barrier identified in the research with women, those identifying as LGBTQ+ and from ethnic minorities.

Support through line managers, formal or informal mentors and networks can enhance careers and progression and thus a lack of these can act as a barrier. These mechanisms can help to identify progression pathways and opportunities which may lack transparency and provide support to gain access to them. They can also counter feelings of isolation.

Networks are particularly important as they can define priorities, values and codes of conduct, and can be used to communicate career opportunities. However, these can be homophilous in that they tend to involve people who share the same defining characteristics. Thus, women and other minority groups may be excluded from these networks and related events and social groups (Hassan et al, 2021; Lan Oo et al, 2019; Fernando et al, 2018).

Research indicates that women may feel isolated in engineering workplaces, with little opportunities for collaboration or to make connections. This can be problematic in sectors where connections as well as recognised analytical technical competence are important in building careers; and where peer evaluation and sponsorship play a role in the promotion process (Fernando et al, 2018; Yonemura and Wilson, 2016). Support and mentoring along with training, development and access to challenging work are identified as factors that are crucial to retaining women within engineering (RAEng, 2018b; Fouad et al, 2019 citing Fouad et al, 2016).

The importance of a supportive line management, a supportive community of women to reduce feelings of isolation, mentoring networks to push and support and counteract the lack of female role models, and having allies and advocates was also found for the construction sector (Fernando et al, 2014; Hasan et al, 2021; WIC, 2018; Worrall et al, 2010), STEM academics (O'Connell and McKinnon, 2021) and those working in the defence industry (Rimington et al, 2019). These support mechanisms, along with supportive significant others, are regarded as the most valuable resource in women's career development and career success (Hasan et al, 2021; Fernando et al, 2014). However, women in engineering and closely related industries suffer from a lack of support from senior members of staff and do not receive as many mentoring opportunities as their male peers (RAEng, 2018a; Bryce et al, 2019).

Isolation and lack of support also affects other minority groups in engineering. Studies in the USA of experiences in engineering education of LGBTQ-identifying persons finds these individuals experience inequality in the form of social isolation or exclusion – they feel less accepted, more ignored, and less comfortable joining in (Cech and Rothwell, 2018; Cech and Waidzunas, 2021). Older research indicates that these individuals may still experience isolation even in good practice employers (Colgan, 2011).

Research with ethnic minorities finds many ethnic minority staff members across a range of industries cite a lack of support from other staff members, particularly line managers, as being a barrier to progression (Holmes and Brown, 2021). The role of the mentor is invaluable and has been used as an intervention in a number of industries; a survey by the CIPD found that a quarter (23%) of ethnic minority respondents whose employers did not provide a mentoring service felt that it would be useful in achieving their true potential at work (CIPD, 2017). A lack of support from senior colleagues leads to issues in confidence, which in turn creates further barriers to progression as well qualified, potential applicants do not apply for promotions as they feel that they are not qualified enough (Callaway, 2021).

There are some concerns around the legitimacy and effectiveness of targeted mentoring and networking. There is evidence within the engineering industry that positive actions such as mentoring schemes exclusively for women have been thought of as being illegal, due to fears of discrimination against male colleagues (RAENG, 2020, p.20). Women may also not want to act as mentors.

Fernando et al (2018) note how some women may seek to distance themselves from other women, in downplaying their identity/femininity, or police other women to ensure they present a favourable image on behalf of women in the organisation (known as Queen Bee Syndrome, citing Derks et al, 2016), so may not want to mentor other women.

Other research, focused on women's career progression in the construction industry, finds mentoring and networks do not lead to better outcomes/career advancement for women as they do for men (although can aid retention), and that individual factors have the greatest influence rather than interpersonal and organisational factors (Francis, 2016; also cited in Hassan et al, 2021). This requires further research, specifically in the engineering profession/sector, and again highlights the lack of evidence of what (and how) interventions work.

Concerns over disclosure

This was a barrier experienced by individuals with disabilities and those identifying as LGBTQ+.

Individuals may have concerns about disclosing disabilities to their employer and/or do not understand the process or purpose of disclosure. They lack understanding over whether it is a simple data collection exercise or an opportunity to access additional support, along with a lack of clarity over how the data may be used, and who may have access to it now and in the future (Vann and Upchurch, 2021). Research (in other sectors) finds disabled staff often feel uncomfortable declaring their disabled status through fear of negative repercussions and can experience stigma or being treated differently and negatively (Lyubykh et al, 2020).

This leads to disabled employees not disclosing and thus not receiving the necessary support or adjustments which in turn compounds their negative experiences through remaining silent (Brewster et al., 2017). However not all individuals have a choice over whether to disclose and those with invisible disabilities have the widest range of options (Evans, 2019).

Individuals who identify as LGBTQ+ also face decisions about whether to disclose their sexuality and/or gender identity at work. Colgan's (2015) qualitative study looking at the intersectionality and the experiences of ethnic minority and disabled LGBT employees found that sexual orientation and gender identity and gender reassignment are not accorded the same status as other equality strands and most organisations were perceived to suffer from a form of 'LGBT-blindness'. Sexual orientation is seen as complicating workplace interactions.

Where colleagues and line managers show limited awareness and support for equality issues, people may choose not to come out at work. Disclosure can be seen as damaging credibility and risky despite a desire to not have to hide key aspects of their identify at work.

The culture in some sectors is seen to reward those who fit the mould of the ideal worker, eg the ideal engineer or ideal scientist, someone who displays certain characteristics or working behaviours (CRAC, 2020; Edgar, 2020).

Pressure to conform to these workplace ideals and values often results in workers with less visible disabilities having to decide between a trade-off between the perceived benefits of additional support versus the possible stigma associated with making their disabilities visible to the employer and not conforming to the identity of the ideal worker. Whereas non-disclosure allows the employee to potentially fit into the ideal worker archetype (Vann and Upchurch, 2021; Lyubykh et al., 2020; Jammaers and Zononi, 2020).

4.3 Working towards inclusion

The literature review identified several actions that could or should be taken to support career advancement and progression in engineering (and related sectors and professions) and particularly to support those from minority/underrepresented groups as these may not be well served by current systems and processes. Indeed, the data analyses presented in section 2 indicates that if changes are not made it will take women approximately 100 years to achieve representation in the engineering profession.

These actions often form part of a wider movement towards inclusion and inclusive practices, and it is difficult to separate out action to support career progression (prevent career deflection) from those more generally aimed at supporting equality, diversity and inclusion. Indeed, recent work by CIPD (Holmes and Brown, 2021) notes addressing career progression inequities is key part of action to work towards equality of opportunity.

The actions noted in the literature stem either from recommendations in response to the barriers identified and explored and therefore act as prompts for organisations; and/or they stem from activities trialled in organisations. However, there was no real evidence in the literature identified of the effectiveness of these actions and impact on minority groups. The lack of robust evaluation may stem from: these being nascent in their development and not yet widely adopted, the fragmented nature of their implementation taking place in individual organisations who may not want to share results more widely, and/or a lack of skills in evaluation within companies and no external (independent) support.

There may however be evidence in the wider literature around effectiveness of inclusive practices more generally, but this was not within the scope of this review. This should be explored further.

Hasan and colleagues' review (2021) provides a useful overview of actions, albeit from the perspective of gender diversity and construction but these can equally apply to other aspects of diversity and other sectors including engineering. Critically the authors highlight the importance of taking a top down and bottom-up approach to diversity issues, and for inclusion to be tackled from a range of spheres of influence.

Initiatives include:

- at macro level: legislative and procedural reforms and using public procurement to leverage action such as providing work experience placements and employment for women, and incorporating employment equality requirements into contracts;
- at micro level within organisations involving practical solutions such as part-time and flexible working arrangements, fair recruitment and promotion procedures, development and effective implementation of policies and disciplinary procedures to eradicate discrimination, bullying and harassment, diversity training of the entire workforce to create necessary attitudinal changes, and commitment from senior and junior management staff;
- and in between, at industry level, with sector-wide codes of practice, a commitment to equality and diversity, and projection of a positive image.

These initiatives are discussed next.

4.3.1 Better intelligence

The literature acknowledges that there is a paucity of data on workforce diversity, and that fine-grained and accurate diversity data needs to be better collected, maintained and continually monitored/analysed to help plan for labour shortages and fill potential skills gaps and to support improvements in practice.

Workforce analytics

It is suggested that diversity data needs to be collected at each stage of the recruitment process and also beyond recruitment to monitor impacts and outcomes for employees at all stages of the employee life cycle including performance management, promotion and exit (RAEng, 2018c and 2018d) and to assess whether processes are fair and provide career opportunities for all (Holmes and Brown, 2021). Also, that there needs to be clear communication of the rationale for data collection (Barnard et al, 2020). There have however been improvements in data collection in recent years among large employers, particularly around disability monitoring (Sayce, 2018).

Work by the Royal Academy of Engineering notes how, in an industry geared towards clear solutions and tangible outcomes, the use of strong quantitative data to infer trends and, with it, social progression should be promoted. Particularly when the 'problem' of inclusion is viewed as one of complex change and intangible outcomes related to experience and individual perception (RAEng, 2017b). The Royal Academy of Engineering go on to suggest that engineering employers should look to measure the percentage of employees who have progressed by diversity characteristic, the percentage of roles filled by internal candidates rather than external candidates by diversity characteristics, and the percentage of each diversity characteristic that choose to take up training and development opportunities compared to representation in the wider workforce (RAENG, 2018c, p.23).

The World Economic Forum (2016) argues that measurement is important, but this needs to be accompanied with target setting and embedded accountability.

Evaluating activities and highlighting good practice

It was noted how more research is needed to examine the impact of policies and initiatives (Hasan et al, 2021) and there were suggestions in the reviewed materials of how to better evaluate inclusion in the workforce. This includes shifting away from case studies focusing on individuals facing barriers which in turn emphasises the inclusion problem; and instead moving to focus on employers who have done things "right." This provides a learning opportunity through lived examples, and in turn can help to create an inclusion framework for employers to follow as a clear "story" exists around how inclusion was made possible, along with suggestions of how to generalise it (Sayce, 2018, p.121).

It was also suggested that organisations should work together, that there is the potential for intra-industry collaboration (WEF, 2016). The data analysis presented above indicates that architecture as a profession appears to be leading the way and so could provide learning opportunities for engineering.

4.3.2 Changing the culture

Hasan et al, note the work of Ackrill and colleagues (2017) asserting that 'without changes to the male-dominated culture, ideas, and discourse present at various operational levels, organizational policies on gender equality will have limited effects' (2021, p12). They therefore conclude that although many organisations have implemented policies to address inequality 'these policies fall short in the face of masculine workplace culture.

The culture is the hardest part of the organisation to change, and recommendations that challenge the dominant culture continue to face considerable resistance' (p12). Similarly, work by Galea et al (2015) looked to understand why gender equality initiatives have failed to bring about change in the representation of women in the construction industry at all levels.

They analysed the policies and initiatives of two large Australia multinational construction firms and concluded that these focused on increasing the numbers of women in the industry rather than addressing practices and outcomes and lacked robustness or adaptability which meant they failed to genuinely challenge the culture. These sentiments are also reflected in the World Economic Forum report (WEF, 2016): 'While in nearly all industries and geographies there has been a marked shift away from deliberate exclusion of women from the workplace, there continue to be cultural beliefs that lead to unconscious biases.

This includes perceptions that successful, competent women are less "nice"; that strong performance by women is due to hard work rather than skills; and assumptions that women are less committed to their careers.' (p4). And reflected in the work of O'Connell and McKinnon (2021) focused on STEM careers in academia who note that to begin to address barriers for women and minoritised groups it requires an enabling institutional environment.

A change in culture requires zero tolerance, creating a safe space backed by policies to protect staff from discriminatory behaviour (Barnard et al, 2020; Holmes and Brown, 2021), whilst at the same time creating space for open and honest conversations about experiences in the workplace (Boughey, 2020; CIPD, 2021) and a truly honest assessment of how bias and power dynamics impact on minority employees experiences (CIPD, 2019). Organisations must ensure that they go beyond a 'corporate veneer of inclusivity' or 'pink washing' to embed concrete practice (Barnard et al, 2020), to underpin policies with company values (Hasan et al, 2021), and need to take a holistic and active approach to how employees are valued and to talent management in order to close diversity gaps (WEF, 2016; CIPD, 2019).

Actions seeking to tackle the pervasive culture and move towards a culture where diversity is valued and inclusion is the norm include:

Offering and promoting flexibilities

Critical to developing an inclusive work environment is providing opportunities and responsive policies that allow all individuals to better achieve their work-life balance. This will include appropriate childcare options, smooth re-entry systems and processes for those who take career breaks, mentoring for transitions, flexible working hours and efforts to encourage take-up and acceptance of different models of working (WEF, 2016; Fouad et al, 2019). Bryce et al (2019) in their work focused on female engineers in the construction industry in Australia made a series of practical recommendations around workplace flexibility to support retention and advancement.

These include actions to:

- encourage establishing limits on working hours and discourage working on weekends to change the workplace culture to value a healthier work-life balance,
- look to fill skills shortages by advertising part-time and flexible work positions,
- harness technology to allow work to be undertaken from home (e.g. access to project folder drives, cloud-based project collaboration systems),
- consider what models of flexible working work best e.g. 9am to 3pm core hours and 3-day-week job share,
- place a higher value on the role of fathers in parenting by promoting flexible working to males as well as females,
- start the process of change towards part-time working by offering part-time work in some roles before opening up to others in order to normalise this form of working,
- have a strong return to work policy which considers the needs of female employees,
- incorporate start early, finish early or start late into project teams (to allow for school pick up/drop off),
- consider running online training so that this can be accessed at a time that suits individuals or running training sessions at a range of times/ days to ensure those working part-time or flexibly do not miss out (also suggested by WIC, 2018).

Engaging everyone in change

There is a role for everyone to shape the culture, not just the HR department (Boughey, 2020). In an industry as dominated by white males as engineering, the role that the majority plays in causing barriers to progression, be it consciously or subconsciously, must be considered. It is proposed that for inclusive cultures to form, a critical mass of white and male allies needs to be formed (RAEng, 2017b, p.8; CIPD, 2021, p28).

The engineering industry therefore needs all its employees to actively contribute to the development of an inclusive work environment. An inclusive, diverse and confident engineering profession is a product of each engineer being aware of their own personal biases, and those biases that have become ingrained in workplace culture under the guise of it being 'the way things are currently done' and to understand the impact these have (RAEng, 2018a, p.45; Boughey, 2020).

However, it is natural that the people who already feel most included – white male engineers - are the least likely to see the need for an increasingly inclusive culture (RAEng, 2017b) but it is important that these individuals are involved in the culture change process and understand the role they play in creating inclusive cultures (McBride-Wright, 2020). Reflexivity

and self-development, both for the employee and employer, will be required going forward. To make progress requires united, concerted action from a range of players, making an inclusive approach one of systemic change, and learning and reflecting from top to bottom (Sayce, 2018, p.119). Engaging everyone also includes spreading influence into the supply/value chain to other employers (WEF, 2016).

Establishing responsibilities

Alongside measurement, it is suggested that targets are set with embedded accountability, with particular accountability for senior management. Line managers, HR and senior management are often the focus for action as they play a key role in supporting diversity and inclusion (Barnard et al, 2020). Also, systems and processes should be auditing to ensure they do not have inherent bias (WEF, 2016). It is important that leadership demonstrates a commitment to supporting those from minority and underrepresented groups in management (WEF, 2016), and for there to be an authentic senior figurehead (Boughey, 2020).

Providing training

Training on valuing diversity, managing a diverse workforce, and attracting, promoting and retaining diverse talent is required (WEF, 2016). This needs to involve all employees so they understand the seriousness of the issues (Lekchiri and Kamm, 2020). As noted earlier, research undertaken by the CIPD finds that 77% of respondents felt comfortable discussing race and ethnicity with their colleagues, but employers need to ensure their staff are well-equipped to have these conversations (CIPD, 2021).

Creating a sense of belonging and voice

Workplace inclusion (and thus supporting career progression) relates to having a feeling of belonging, having a voice, and being valued for possessing unique and authentic abilities and skills. It is important that this sense of belonging stems from the feeling that conformity is not required, and that differences are valued, rather than distrusted (CIPD, 2019; Boughey, 2020; Holmes and Brown, 2021). On an organisational level workplace inclusion involves valuing differences, and allowing employees to have opportunities to develop, participate and use their voice to influence change in the workplace regardless of what their background may be (CIPD, 2019).

Other actions include: looking beyond outreach, recruitment and entry, as an inclusive workplace culture needs to go beyond recruitment to allow all employees to succeed and thrive (Boughey, 2020); establishing a specific diversity and inclusion strategy (Ethnic Dimension, 2014); ensuring people feel able to report conflicts and that these are taken seriously (CIPD, 2021); and careful use of language in formal communication and materials (Cech et al, 2017).

4.3.3 Greater support for minority groups

Many of the barriers identified in the research literature point to a specific lack of a resource or exclusion from a particular mechanism that supports career development for those from minority groups. Therefore, to address these gaps or inequity in progression there needs to be targeted action to redress the balance. However, as discussed above, in providing support it is imperative that employers recognise the importance of intersectionality, and that just considering one aspect of someone's identify does not give a complete picture of their experience at work (CIPD, 2021).

Visible role models in senior positions

There need to be present and visible role models so that individuals from minority groups feel able to enter and succeed in engineering as well as other fields (Lezotte et al, 2020; Cech et al, 2017), including individuals with visible disabilities (Brewster et al, 2017). Role models indicate possibilities within organisations and can also act as guides or mentors (RAEng, 2018b). Some individuals want to stand as role models and to provide organisations with unique insights into problems faced by some of their employees (Jammaers and Zanoni, 2020; Merrick, 2017a).

Coaching and mentoring to support career development plans

Mentors can provide specific and tailored support and encouragement and are used as an intervention in several industries and can be a way to counteract the lack of diverse role models (WIC, 2018). A CIPD survey found that a quarter (23%) of ethnic minority respondents whose employers did not provide a mentoring service felt that it would be useful in achieving their true potential at work (CIPD, 2017). Mentors are considered a valuable resource in career development and can be used to improve the status of underrepresented groups to persist and succeed and to help eliminate bias (Lekchiri and Kamm, 2020; Hasan et al, 2020; and O'Connell and McKinnon, 2021).

Networks

The CIPD asserts that employers should look to build peer support and allyship networks, these can act as the first point of contact that individuals from minority groups (such as those identifying as LGBTQ+) can approach when they have faced bullying and harassment. Members of networks therefore should have appropriate training to be able to signpost to sources of internal and external support (CIPD, 2021). Networks also provide wider support and encouragement and can foster inclusion (Colga, 2015). Cech and Waidzunas (2021) argue that STEM workplaces need to provide LGBTQ+ employees opportunities to network and seek support from one another, from organisational leadership and from STEM professional societies. O'Connell and McKinnon (2021) also argue that having allies through communities and networks helps to develop a sense of safety and belonging.

The CIPD study on ensuring equality of career progression opportunities (focused on race equality and drawing on a survey of employees across a range of sectors) finds that being in the right place at the right time was perceived to be the most commonly cited factor enabling career progression. The authors assert that this can be supported by encouraging employees to build relationships and providing opportunities to collaborate, create connections and share knowledge through work structures (Holmes and Brown, 2021).

Involvement of underrepresented groups in developing solutions

It is noted in the literature that the development of many inclusion solutions in engineering and beyond lack the very perspectives of people they aim to reach and support. In industries where diversity is lacking, this often means that the perspectives of women, people with disabilities, the ageing population and those with other minority characteristics are ultimately ignored (IncEng, 2017).

Exposure to opportunities

Enabling stretch and development is important to career advancement and this involves providing opportunities for all employees and to encourage participation from those who may not get an opportunity or would not ordinarily put themselves forward (Boughey, 2020). This can also involve exposure to opportunities for training (Brewster et al, 2017; Fernando et al, 2014; Holmes and Brown, 2021). Fernando et al (2014) looked at career success of women in professional roles in the construction industry in the UK and used case studies and data analysis to identify career success factors and highlighted the importance of soft skills (as well as hard, technical skills) – the ability to work with people, take opportunities, confidence, adaptability, communication skills, dedication, competence, focus, integrity, leadership skills, ability to bring teams together, honesty, networking, and a logical approach to business problems. These provide useful pointers to the industry on what organisations could do to support the advancement of professional women.

Others include support for disclosure and bringing one's 'whole self' to the work environment (Lyubykh, 2020; RAEng, 2018a; Colgan, 2015).

4.3.4 Supporting careers

Fouad et al (2019) looked at gender differences in aspects influencing individuals to leave engineering and concluded there are gender differences in reasons for departure but there are also overlapping values and reinforcers important in these decisions. They argue that for organisations to engage and retain both female but also male employees they should create workplaces that emphasise opportunities for advancement, help employees to achieve their own goals, and enable good supervisory relationships. This suggests that general work to support careers can be helpful.

Early exposure to the engineering industry

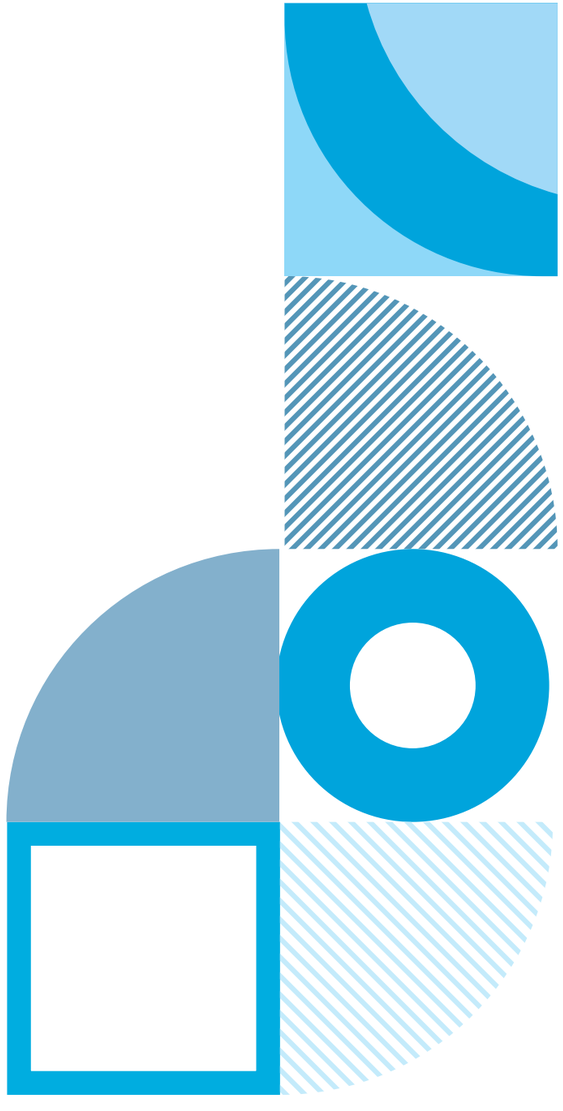
Underrepresented groups need more exposure to the engineering industry to make it appear as a viable career path in terms of achievability and longevity (Sayce, 2018); and negative attitudes and perceptions in schools towards diversity and the engineering profession need to be tackled (Lezotte et al, 2020). Work with schools and in higher education shows improvements in how students perceive themselves as being able to become an engineer as well as improvements in how accessible the career path is perceived to be (RAEng, 2018d).

However more radical action is required to create more awareness in the early years of social development of boys and girls regarding equality (Hasan et al, 2021). This is a key area of action for wider policy work and there is a large body of literature focused on work with children, young adults, parents and teachers, and on work in education settings but this falls outside the scope of our review.

Supportive line managers and supervisors

Understanding and support from managers and from colleagues is important (Brewster et al, 2017; CIPD, 2017; Holmes and Brown, 2021) and can lead to improved confidence and enhanced careers and progression (Fouad et al, 2019; Fouad et al, 2016; Fernando et al, 2014). This may require training for line managers in necessary skills including how to support the career development of those who report to them (Holmes and Brown, 2021) but also to understand the legal obligations that employers have to their staff (CIPD, 2021b).

In respect of disabled employees, supportive actions can include managers asking about the types of support they can provide and what accommodations can be made going forward, signposting appropriate support, and understanding that an employee may have days where they do not feel one hundred percent (Kenyon, 2020; Vann and Upchurch, 2021). Employers need to understand the complexity of disabilities and ensure that they approach them with care and understanding as this will enable staff to feel more comfortable disclosing their disabilities and to engage in wider activities (Brewster et al, 2017).



05

RECOMMENDATIONS FOR THE SECTOR

Recommendations for the sector

There is considerable activity in the engineering sector to try to address inequality and improve diversity and inclusion, particularly at entry, and once in organisations it can be regarded as 'job done'. However, career deflection continues to be experienced with individuals failing to progress in or sustain careers in engineering. The wider research literature indicates that barriers continue to be experienced by minority groups, and minority groups continue to be underrepresented at senior levels and to leave the industry in greater volumes. Similarly, our data analysis indicates women, in particular, are significantly underrepresented at all levels in engineering roles and have much lower levels of retention. The data indicates that disabled individuals and those from ethnic minority groups are not necessarily disadvantaged in engineering but these high-level and aggregate statistics may hide more challenging patterns, More needs to happen to effect real change, for improvements to be seen and to narrow the gap, especially for women. Further action should be taken to understand how those from ethnic minority backgrounds, with disabilities and who identify as LGBTQ+ are faring and how they can best be supported to build successful and rewarding careers in engineering.

Below are a series of recommendations for engineering employers and the sector more broadly. These can form the basis for a set of principles to work towards, and a set of indicators to benchmark performance.

Taken together the recommendations highlight the need for the sector to work together to change the pervasive and damaging culture. Culture change is difficult, but this should not stop all employers and individuals from doing their bit. The whole sector needs to get behind this endeavour and sharing experiences and learning from organisations who are leading the way will help. It will also be important to involve those from minority and underrepresented groups in the development of initiatives to ensure these have appropriate objectives and approaches, and to gain critical feedback on progress which may be challenging to hear.

5.1 Recommendations

The sector lacks intelligence to help it to move forward and ensure its efforts will make a difference.

Recommendation 1: Collect better monitoring data

- Use workforce analytics and diversity data to spot patterns, help reduce staff turnover and monitor impacts and outcomes of internal processes.
- More specifically, diversity data needs be better collected and analysed at all stages of the employee life cycle including application and recruitment, performance management, promotion, and leaving stages. To improve intelligence around promotion, monitor the proportion of roles filled internally and by diversity characteristics.
- Benchmark retention and workforce composition against trends in wider society and against leading sectors and good practice employers. Using the correct data to benchmark against allows employers to see how far away from a suitably diverse workforce they are at all levels and to assess progress.
- Use workforce monitoring, coupled with bespoke research, to evaluate the impact and effectiveness of initiatives aimed at reducing career deflection.
- Be clear about the rationale for data collection.
- Share and publish diversity performance data to demonstrate a commitment to improvement, and to improve the wider intelligence of the sector.

Recommendation 2: Undertake further research

- Explore barriers to career progression in more detail through interviews with women, those with an ethnic minority background, those with disabilities and those with other diversity characteristics.
- Interviews need to be with those who are in the profession and those who have recently left. Interviews with leavers should focus on reasons for leaving and what would have made them stay.
- Consider use of:
  - a) regular staff surveys to explore perceptions and experiences
  - b) exit surveys with leavers to understand their reasons (push or pull factors)
  - c) interviews with senior leaders from diverse backgrounds to understand facilitators.
  - d) independent evaluations of diversity initiatives to understand what works.

The sector doesn't value, and offers limited opportunities for, part-time and flexible working. This is a key barrier for women and others looking to achieve a good work/life balance.

Recommendation 3: Promote alternative working patterns

- Promote and normalise flexible working arrangements as standard practice to ensure employees can achieve a good work-life balance regardless of diversity characteristics. This includes but is not limited to part-time work, flexible hours, job-share, and working from home.
- Harness the opportunity presented by the pandemic which has accelerated moves to flexible and home working.
- Move away from the culture of working long hours and presenteeism which many believe is necessary in order to stay and progress. Many who do not work long hours feel like they are less valued.
- There is an outflow of employees who wish to take a career break (to have children for example), to ensure talent is not being lost there should be a focus on returners, by promoting flexible working and supportive return to work policies.

Conscious and unconscious bias operates to deny minority groups access to experiences, training and sponsors that could support their career development.

Recommendation 4: Ensure equal access to developmental opportunities

- Ensure employees who may be in the minority are not overlooked for training and development opportunities that will allow them to develop (technical and soft) skills needed to progress.
- Ensure equality in exposure to diverse and challenging experiences and tasks that support progression including larger projects, client contact, leading teams. Avoid bias in assigning roles and tasks which reinforce stereotypes and restrict access to development opportunities.
- Ensure transparency of progression opportunities and promotion procedures.
- Ensure all employees have the resources needed to do their jobs well.
- Ensure all employees have a 'voice'.

Individuals in the minority in the engineering industry, a sector which is dominated by white, male, able-bodied men, can feel isolated and marginalised, lack confidence and belief in their potential to progress, and not able to engage fully in their work by hiding key aspects of their identities.

Recommendation 5: Provide a range of employee support

- Underrepresented groups need more exposure to role models in the engineering industry. Ensure there is diversity at senior levels as this can support the development of 'visible and vocal' role models from diverse backgrounds to indicate the career possibilities for others.
- Provide opportunities for employees from diverse backgrounds to network and seek support from one another. Look to build peer support and allyship networks. Also work to open-up existing networks and networking events to those from underrepresented groups as these can be used to communicate career opportunities.
- Provide opportunities for mentoring from senior staff for those from underrepresented groups (this can be virtual) to encourage professional and personal growth.
- Provide access to careers support and supportive line management who can act as advocates and sponsors and facilitate career conversations.

Despite the existence of policies and practices to support diversity and tackle inequality, and willingness for the sector to change, discrimination is still experienced by minority groups in engineering. The masculine workplace culture in engineering is getting in the way.

Recommendation 6: Tackle discrimination

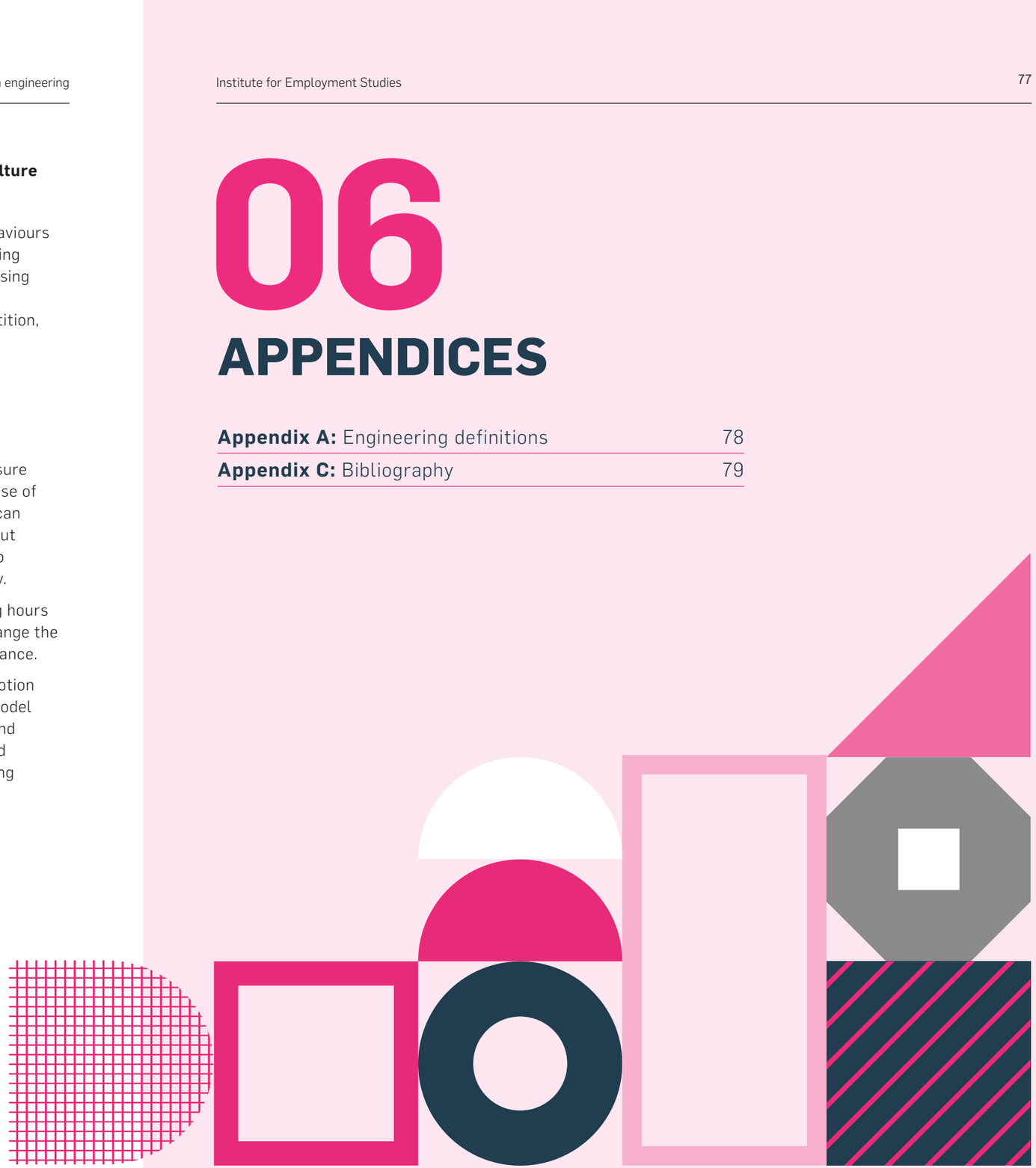
- Understand how discrimination can be experienced or perceived: harassment, bullying/aggression, homophobia, racism, sexism, ableism, stereotyping, pressure to fit in, role assignment, professional devaluation, exclusion, isolation and marginalisation.
- Ensure employees can report issues and that they are taken seriously. Take a zero-tolerance approach to discrimination, bullying and harassment.
- Promote inclusion as a company-wide commitment with senior-level endorsement. Equality, diversity and inclusion is not just for HR, nor should it be solely the responsibility of those from diverse groups to bring about change. Avoid tokenism.
- Provide equality, diversity and inclusion training throughout the organisation. Encourage reflexivity and self-development.
- Audit processes and policies to ensure there is no inherent bias – this includes recruitment and selection, access to training, promotion processes, pay and reward.
- Monitor the impact of activities and initiatives and be mindful of the potential for negative consequences.

Recommendation 7: Tackle the macho culture

- Understand how a macho culture can be experienced or perceived: attitudes, behaviours and perceptions of others, not able to bring 'real self' to work, uncomfortable discussing the personal, long inflexible hours and presenteeism, traditional values, competition, endurance of stress and discomfort, and particular forms of socialising.
- Promote a change in culture for employees to be more collaborative.
- Promote a change in culture to allow individuals to feel comfortable to disclosure their identities and that will create a sense of belonging for all, and where individuals can have open and honest conversations about their experiences in the workplace. Equip individuals to be able to discuss diversity.
- Encourage establishing limits to working hours and discourage working weekends to change the culture to value a healthier work-life balance.
- Recognise the limitations inherent in a notion of an 'ideal' engineer or 'ideal' working model and seek to move away from this fixed and singular ideal (which creates insiders and outsiders or others) to tackle stereotyping and support valuing of diversity.

06

APPENDICES



Appendix A: Engineering definition

This is the definition used for engineering (occupations) in the analysis of the Labour Force Survey and Understanding Society.

Table A: Engineering occupational definition

Atkins occupational definition (SOC 2010)	Group title
112	Production Managers and Directors
212	Engineering Professionals
213	Information Technology and Telecommunications Professionals
214	Conservation and Environment Professionals
215	Research and Development Managers
246	Quality and Regulatory Professionals
311	Science, Engineering and Production Technicians
312	Draughtspersons and Related Architectural Technicians
521	Metal Forming, Welding and Related Trades
522	Metal Machining, Fitting and Instrument Making Trades
523	Vehicle Trades
524	Electrical and Electronic Trades
525	Skilled Metal, Electrical and Electronic Trades Supervisors
531	Construction and Building Trades
811	Process Operatives
812	Plant and Machine Operatives
813	Assemblers and Routine Operatives
814	Construction Operatives
821	Road transport Drivers
822	Mobile Machine Drivers and Operatives
823	Other Drivers and Transport Operatives
No. of categories	**21**

Source: IES, 2021

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