The (un)balancing act: the impact of culture on women engineering students' gendered and professional identities

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The (Un) Balancing Act: The impact of culture on women engineering students' gendered and professional identities

By

Abigail Powell

A Doctoral Thesis

Submitted in partial fulfilment of the requirements
for the award of
Doctor of Philosophy
Loughborough University

May 2009

CERTIFICATE OF ORIGINALITY

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25/05/2009 ..... (Date)

Abstract

This thesis examines the impact of engineering cultures on women engineering students' gendered and professional identities. It is simultaneously focused on exploring how identity shapes, and is shaped by, women's experiences of engineering cultures and the relationship between gendered and professional identities. The research is set within the context of existing research on women in engineering, much of which has focused either on women's experiences in industry or experiences of staff in academia, which does not acknowledge the importance of higher education (HE) as a gatekeeper to the engineering professions. Furthermore, despite numerous initiatives aimed at increasing the percentage of women entering engineering, the proportion of women studying engineering has remained stable, around fifteen percent, for the last few years.

The research is grounded in an interpretivist approach, although it adopts a multimethod research design. Specifically it draws upon qualitative interviews with 43 women and 18 men engineering students, a questionnaire with responses from 656 engineering undergraduates and two focus groups with 13 women engineering students from seven departments at one university. These datasets are analysed with the aid of NVivo and SPSS to explore women engineering students' career choices; women's experiences of the HE engineering culture; the relationship between engineering education culture and women's identities; whether there are cultural nuances between engineering disciplines; and, implications for strategies to attract and retain more women in engineering.

Key findings from the research are that women and men make career choices based on similar factors, including the influence of socialisers, knowledge of the engineering professions, skills, ability and attributes, and career rewards. However, the extent to which each of these factors are important is gendered. The research also highlights key characteristics of the HE engineering culture, including competition, camaraderie, gendered humour, intensity, more theoretical than practical, help and support for women students and reinforcement of gender binaries. These findings all suggest that women are assimilated into the engineering culture or, at least, develop coping mechanisms for surviving in the existing culture. These strategies reveal a complex and difficult balancing act between being a woman and being an engineer, in claiming a rightful place as an engineer, denying gendered experiences and becoming critical of other women. The research also tackles two key issues, rarely discussed in the extant

literature. Firstly the help and support women students receive from lecturers and other staff, and the negative impact this has, and may continue to have, on women. Secondly, the analysis of discipline differences shows that design and technology is significantly different from other engineering disciplines in terms of culture(s) and women's experiences.

The thesis concludes that women's enculturation into engineering results in their 'doing gender' in a particular way. This means that women's implicit and explicit devaluing and rejection of femaleness, fails to challenge the gendered cultures of engineering and, in many ways, upholds an environment which is hostile to women.

Keywords:

Career choice, culture, engineering, gender, higher education, identity, multi-methods, professionalisation, women.

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Contents Summary

Detailed Contents

List of Figures

1. Introduction

This thesis examines the impact of engineering cultures on women engineering students' gendered and professional identities. It simultaneously focuses on exploring how gendered and professional identities shape women's experiences of engineering cultures and how women's experiences shape their gendered and professional identities. It also analyses the relationship between women engineering students' gendered and professional identities.

The introduction considers the background or context of this area of research; elaborates the research questions, aims and objectives; suggests how the research contributes to new knowledge; considers some of the limitations of the scope of the research; explains some of the key concepts of the research, particularly engineering, gender, identity and culture; provides a brief overview of the research methodology and design; addresses the role and background of the researcher; and finally, outlines the structure of the rest of the thesis.

1.1 Background

The UK engineering industry has long been considered quantitatively and hierarchically male-dominated. It has a popular image of being tough, heavy and dirty (Evetts, 1996) and is gendered by its association with these traditionally masculine values. This association has rendered engineering as an occupation which is perceived as unsuitable for women, despite contradictory evidence that women are generally perceived to be better qualified and more highly motivated than their male colleagues (SHEFC, 1997). Women's continuing minority status in engineering has been explained in various ways, including poor or inadequate careers advice at school; early differential socialisation of girls and boys; lack of support from family, friends and professional engineers; and cultural and occupational barriers (Dryburgh, 1999).

Bagilhole (1997) maintains that there is a strong business case for increasing women's representation in male-dominated workplaces. The beneficial effects of identifying and removing discriminatory and hostile practices are direct and quantifiable, and include the reduction of costs related to staff turnover, reduced litigation fees, a more pluralistic self-image, improved customer service and access to a largely untapped reserve of skill and talent (Dainty et al., 2004). However, over-emphasis of a business case approach risks implications that *'women are perhaps the 'last resort''* (Henwood, 1996:

200). Thus it is argued that it is the skills shortage, rather than the development of an inclusive approach, that has led more women into science, engineering and technology (SET) professions (Devine, 1992) and the retention of women in these professions is commonly extolled as good business sense (Fielding and Glover, 1999). Therefore, while the business case has influenced progress in changing employer perceptions, the use of a business argument alone is problematic (Bagilhole et al., 2007) and may lead women to question the good intent of equal opportunities policies that do exist (Devine, 1992).

Nevertheless, over the past few decades numerous initiatives have attempted to redress the under-representation of women in engineering. In 1984, for example, the Women into Science and Engineering (WISE) campaign was established, with the support of the Equal Opportunities Commission and Engineering Council, and in 2004 the UK Resource Centre for Women in SET was launched to increase the participation and position of women in SET. While such initiatives have had some success in increasing the proportion of women studying SET subjects, Ellis (2003), amongst others, suggests we need to understand why there have been so few subsequent significant changes in SET employment for women. Glover (2002) shows that women represented 3% of engineering and technology undergraduates in 1973, increasing to 8% in 1984 and 14% in 1994. However, these increases now appear to have plateaued with HESA (2008) statistics showing that women represent 15.9% of engineering and technology students in 2006/07. This figure is significantly lower than the average across all subjects (57.2%). The figures also vary widely by engineering discipline. Furthermore, the increase in women SET students has failed to translate into an equivalent increase in women SET professionals, with figures suggesting that in 2006 women only account for 5.4% of engineering professionals compared to an average 48.7% across all occupations (ONS, 2007). Finally, ETB (2008) indicates that of the women who do graduate with a SET degree, only 27% go on to pursue a SET career compared to 54% of men.

Furthermore strategies to increase numbers of women in engineering are arguably based on a critical mass thesis, which suggests that a particular number - or critical mass - of women are required in order to create tolerance of difference and to foster the inclusion of women (Powell et al. 2006). In other words, critical mass addresses the number of people needed to change an organisational culture (Morley, 1994). However these strategies have been criticised as insufficient (see Glover, 2002; Henwood, 1993; Moore et al., 2005; Powell et al., 2006) as increasing numbers of

women alone fails to prevent the reproduction of traditionally masculine cultures (Knights and Murray, 1994). As Etzkowitz et al. (2000: 245) explain, in the context of women in academic science: *''critical mass' is meaningless when women are isolated and unknown to each other, when affiliation with other women is too stigmatising, or the female faculty model available reflects an archaic, male stereotype impossible to emulate or incorporate into a contemporary professional identity'*. These arguments have led to an increase in research, in engineering and other male-dominated fields, addressing women's professionalisation and enculturation into their occupation (see for example, Faulkner, 2005a; Miller, 2002). However, it is also argued that such assimilation is part of women's strategy to cope or survive in such male-dominated environments.

At the same time, there has been increasing interest in the gendering of higher education (HE) with suggestions that academic men have defined not only what is taught in universities, but also how it is taught, in a way that marginalises women (Bagilhole and Goode, 1998). Lewis (1995), for example, found engineering teaching to be strongly biased towards men: '*The research questions, methods, criteria of success, and styles of teaching are male defined, and consequently, the knowledge itself reflects a bias towards a male cognitive style in its practices, theories, and ways of teaching'*. As a result, Sagebiel (2003) argues that an improved curriculum would make both the climate and content of teaching appropriate to attract and retain both women and men.

Finally, much previous research undertaken into women's experiences and careers in engineering (e.g. Evetts, 1996) has tended to treat 'engineering' as a single, homogenous sector, with little consideration of whether specific structures and cultures underpin individual engineering disciplines and professions, something this research intends to address.

1.2 Research questions, aims & objectives

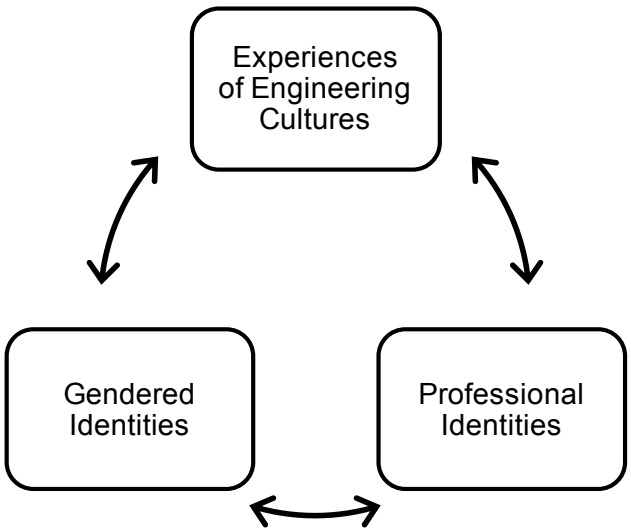
This contextual background goes some way to underpin the research presented here. Firstly, the failure to translate increases in the, albeit small, proportions of women studying engineering into women employed in engineering raises questions about how women experience the HE environment and their relationships with other students and teachers. This is particularly interesting in light of other research which has highlighted the gendered nature of HE. Secondly, notions around women's professionalisation into male-dominated fields, including a failure to challenge 'masculine' norms and values,

raise questions about whether women entering engineering already uphold these values or whether assimilation into engineering cultures occurs during the process of their education. For example, if women already uphold so-called masculine values, it might be expected that women and men engineering students' career decisions would be very similar. Thirdly, do women themselves perceive there to be a conflict between being a woman and working in engineering, an area which has already been shown to be inherently masculine? If so, how do they make sense of this conflict and what effect does this have on their own identities? Finally, do these findings have any implications for strategies to increase the proportion of women in engineering which, to date, have only had limited success? The underlying, and intertwining, research questions are therefore:

- What is the relationship between engineering cultures and women engineering students' gendered and professional identities?
- Do women engineering students challenge or maintain existing engineering cultures? How and why do they do this?

Given these questions the research aims to examine the impact engineering cultures have on women engineering students' gendered and professional identities. It is simultaneously focused on exploring how gendered and professional identities are shaped by women's experiences of engineering cultures and how women's experiences are shaped by their gendered and professional identities. It will also analyse the relationship between women engineering students' gendered and professional identities. The concepts of identity and culture will be discussed in detail throughout the thesis but because of their theoretical nature, they will be explored through less abstract concepts, particularly career choice and engineering HE. Career choices are used as an indication of the identities women engineering students uphold, while the culture women experience on a day-to-day basis is explored through HE engineering.

Figure 1.1 Relationships to be explored in research

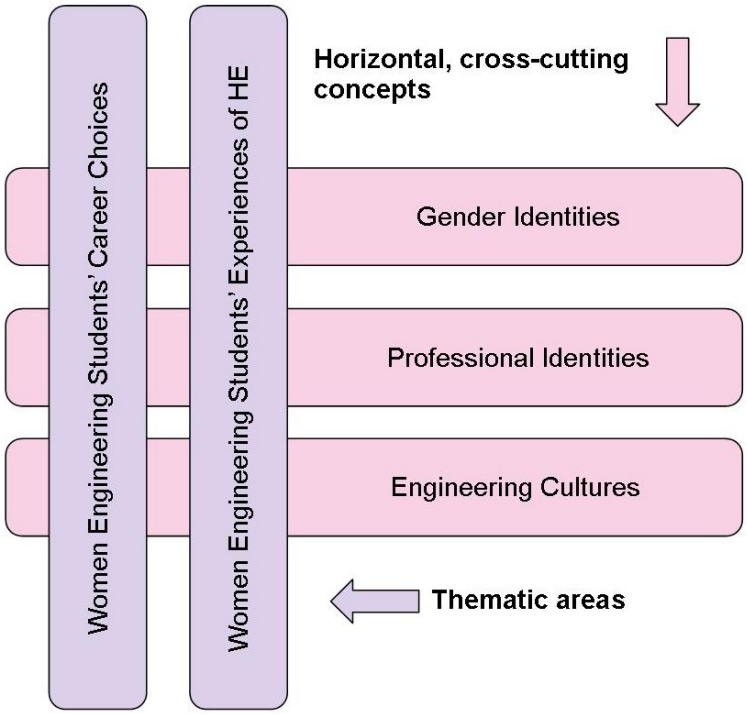


The specific objectives are to:

- Examine women engineering students' career choices and whether career decisions are gendered;
- Investigate women engineering students' experiences of HE engineering cultures;
- Explore the relationship between engineering education cultures and women engineering students' gender and professional identities;
- Assess whether women's attitudes, experiences and environment vary according to their engineering discipline;
- Address what implications the findings may have for strategies and policies to attract and retain more women in engineering education and careers.

The relationship between the different issues being investigated in the current research is presented diagrammatically below:

Figure 1.2 Relationship between themes and concepts in the research



1.3 Contribution to knowledge

This research contributes to existing knowledge, by generally addressing the topic of women's experiences in engineering education. While there has been much research into how and why both the engineering industry and academia have excluded women, gender research in academia has tended to look at staff rather than students and research concerning women in engineering has focused either on recruiting or promoting the industry to women of school age, or retaining women once they are employed in the engineering sector. Other HE-related literature has tended to focus on the problem of recruitment, rather than course content or approach. More specifically, the research tackles two issues which have rarely been discussed in the extant literature: the help and support women engineering students receive from lecturers and support staff, including how women experience this and the potential impact it has on them; and, the differences that exist between disciplines, in terms of the cultures and women's experiences.

1.4 Limitations and further research

The research is an exploratory study of women engineering students' experiences in one university. The extent to which the findings can be generalised is limited, although

not impossible given the similarities between this and other research. Nevertheless, future research should further address: the heterogeneity of women's experiences, in terms of ethnicity, class, age, sexuality and disability; how men are gendered and potentially marginalised by masculine engineering cultures; what happens to women once they leave the education system, in the first few years of their careers; and whether any of the findings are applicable to women's experiences in other disciplines, not only in other male-dominated areas, but also in social sciences and humanities.

1.5 Key concepts

Some of the key concepts that have been introduced, and will continue to be used throughout the thesis are defined below, although more detailed discussion of some of the concepts will be presented in chapters two, *Gendered Cultures and Identities,* and three, *Entering the Engineering Profession.*

1.5.1 Engineering

The term 'engineering' is used broadly throughout the thesis to refer more generally to 'engineering and technology'. Within the scope of the thesis, engineering includes subjects allied to engineering and technology and architecture, building and planning[1], including:

- Civil engineering
- Mechanical engineering
- Aerospace engineering
- Electronic and electrical engineering
- Production and manufacturing engineering
- Chemical, process and energy engineering
- Materials engineering and technology
- Design and technology
- Building and construction
- Planning.

While the key focus of the thesis is on engineering and technology, some literature is drawn from the wider area of SET, where relevant, as this area has also been

[1] These subjects were compiled using HESA's (2008) subjects of study and summarising the subjects available to study at the university investigated in the research.

researched in terms of its male-dominated nature and the impact this can have on women.

1.5.2 Gender

Gender is used throughout the thesis to refer to characteristics, traits, behaviours and competencies which are often defined as masculine or feminine. Wilson (2003) suggests that gender is context dependent and a highly flexible process, and as such cannot be used as a category in the same way that biological sex often is. Rather gender is a process which is learnt throughout childhood and adulthood. As Alvesson and Billing (1997) write, gender is the effect of social definitions and internalisation of what it means to be a man or a woman and is most clearly articulated by Simone de Beauvoir who asserts that *'one is not born, but rather becomes, a woman'* (1949: 267). Furthermore the separation of sex and gender implies that a certain sex does not necessitate a certain gender, even though there may be powerful cultural constraints at work (Cole, 2000).

1.5.3 Masculinity and femininity

While it is increasingly recognised that there are multiple masculinities and femininities which vary over time and place (see for example: Connell, 1987; McLean et al., 1997), the terms masculinity and femininity are referred to throughout the thesis with reference to the traditional or stereotypical notions of the concepts. Thus masculinity refers to characteristics, traits and competencies stereotypically associated with being a man, while femininity refers to those traits traditionally associated with being a woman (Pilcher and Whelehan, 2004). So, for example, some masculine characteristics include self-assertion, independence, control, competition, rationality, while femininity may be described in corresponding terms such as dependence, cooperation, receptivity, acceptance, emotional, intuitive, empathetic (Alvesson and Billing, 1997). However, whereas the concept of masculinity is popularly associated with being male and femininity with being female, it is recognised that very few women or men will fit into either categorisation. Furthermore, as discussed in the definition of gender, it is likely that women, at varying times and places, may behave in terms that could be described as masculine and men in terms that could be described as feminine. In addition it is not only people that are described in terms of masculinity and femininity. There has been a strong duality between masculinity and technology, for example, as stated above engineering is often described as tough, heavy and dirty (Evetts, 1996),

characteristics often associated with masculinity. More generally it is argued that the dogma of science is masculine and set in opposition to femininity. (For further discussion of the relationship between technology and masculinities see Faulkner (2000a), Gill and Grint (1995), Henwood (2000), Murray (1993) and Wajcman (1991)).

1.5.4 Identity

Lawler (2008) suggests that the notion of identity relates to sameness and difference, by which she means that individuals can identify themselves as the same as some people and different to others. Lawler also argues that identities can be varying, contradictory and in tension. So for example, how an individual identifies themselves, may not be how other people identify them (for example, the individual may identify as a 'woman', while other people identify them as a 'girl'). However, as an individual it is also possible to have identities which may be in tension with one another (for example, 'mother' and 'worker'). It is also feasible that individuals will emphasise different aspects of their identity at different times and places. Thus Bruni and Gherardi (2002) indicate that individual identity is not fixed, but rather it is constructed through enactment and performativity (Butler, 1990). Furthermore, McLean et al. (1997) suggest that identity is not usually a conscious process, which means that the ideas individuals hold about themselves can be contradictory and inconsistent. Identity in the current research is particularly focused on gender and professional identities and whether women engineering students' experience a tension between their gender identity as 'woman' and their professional identity as 'engineer'. The meaning of identity is further explored in section *2.2 Identities.*

1.5.5 Organisational cultures

Alasuutari (1995) states that the concept of culture refers to a 'collective subjectivity'; '*a way of life or outlook adopted by a community*' or social group (1995: 25). McIlwee and Robinson (1992) suggest that culture manifests itself through day-to-day activities and interactions. Much of the extant literature on the nature of culture refers to organisational cultures, with reference to organisations, not only as companies or workplaces, but any group of people organised for a particular purpose. Thus, in this research the organisation is the engineering classroom, where students are organised for the purpose of learning engineering.

Greenwood (1997) states that the culture of an organisation describes the unique way in which people act or interact within it. Bagilhole et al. (2007) suggest that

organisational culture is a dynamic process that can be conceived as something an organisation *has*, something an organisation *is,* and something an organisation *does.* Wajcman (1998) suggests that cultures are produced and reproduced through the negotiation, sharing and learning of symbols and meanings. It simultaneously shapes human action and is the outcome of human action. Furthermore a variety of subcultures can co-exist within a single organisation (Wajcman, 1998; Brown, 1995).

In addition, much research has argued that there is a gendered aspect to organisational cultures (see for example, Hofstede, 2003; Mills, 1988). Particular occupations, for example, are seen as single-gendered (despite the mix of individuals engaged in the work) because of the symbolic qualities needed to do the work (Bottero, 1992). Itzin (1995) characterises masculine-gendered cultures, such as those in engineering, as hierarchical, patriarchal, sex-segregated, sexually divided, sex-stereotyped, sex-discriminatory, sexualised, sexist, misogynist and resistant to change. The combination of these features forms a workplace where traditional masculinities are a dominant element of corporate cultures (Hofstede, 1984). This debate is discussed further in section *2.1 Organisational cultures.*

1.6 Methodological overview

The research is grounded in an interpretivist approach, although it adopts a multimethod research design. Specifically it draws upon qualitative semi-structured interviews with 43 women and 18 men engineering students, combined with a questionnaire of 656 engineering undergraduates and two focus groups with 13 women engineering students. The relationship between the methods employed, the research questions, objectives and structure of the thesis is outlined in figure 1.3 (on page 12). Both the interviews and questionnaire address two key themes explored in the research: influences and motivations for choosing an engineering degree; and, cultures of engineering and students' experiences of these. While the questionnaire examines students' attitudes and allows extensive comparisons between women and men, and engineering departments, the interviews explore the issues in more depth, with a particular focus on how and why students' attitudes persist. The focus groups provided an opportunity to further develop issues raised in the other datasets as well as allowing women to compare and contrast their experiences. The findings from the data collection are interrogated thematically, with comparisons between the datasets in both chapter five *Women Engineering Students and Career Choices* and chapter six *Women's Experiences of Higher Education.*

1.7 The research and the researcher

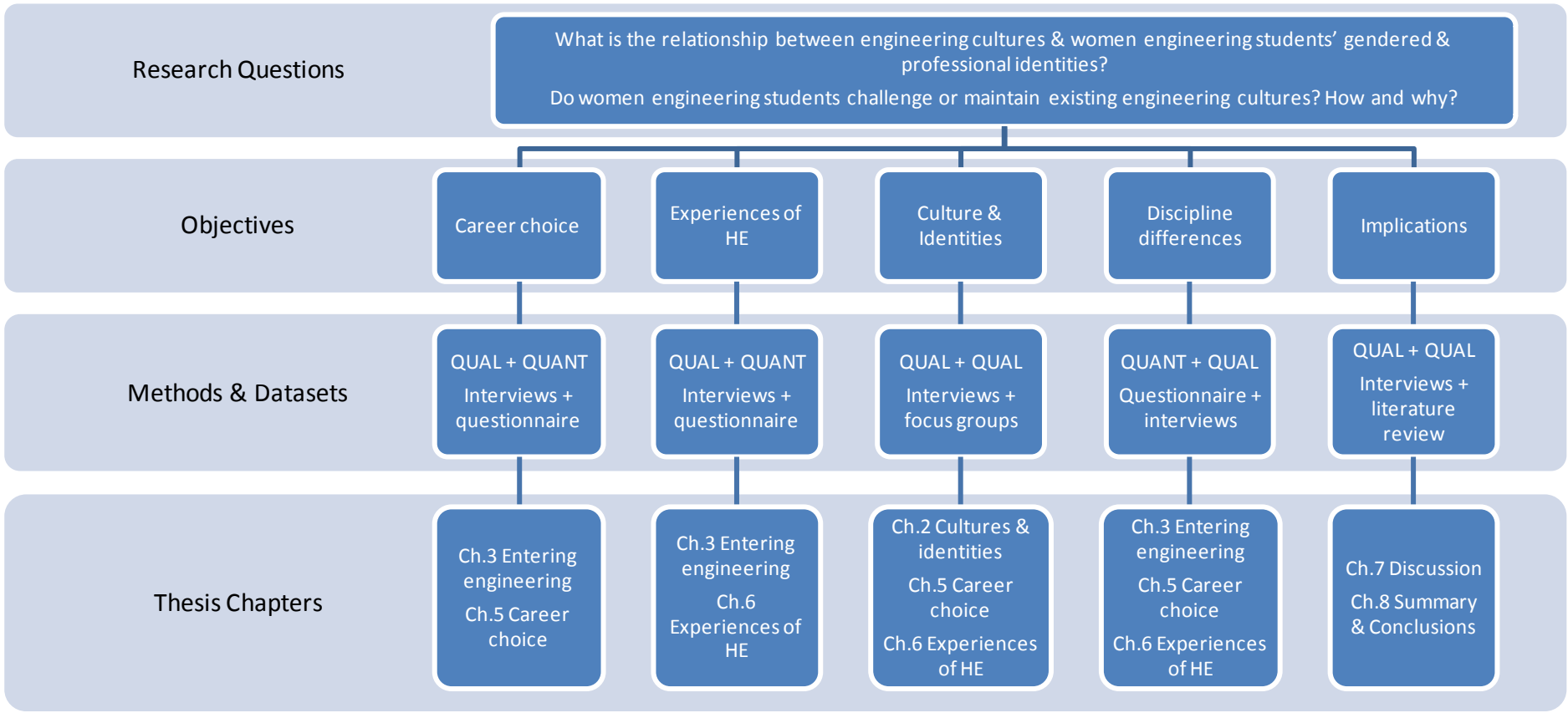
The researcher's interest in women engineering students' career choice and experiences of HE was grounded in a wider interest in equal opportunities, gender and identity. It was also informed by work undertaken as a full-time Research Associate on two related projects: the first was funded by the Economic and Social Research Council (ESRC) and titled, 'Women engineering students' workplace experiences: impact on career intentions' (RES-000-23-0426) and took place from 2004-2006; the second was a smaller project funded by the Engineering Centre for Excellence in Teaching and Learning (engCETL) and was established in 2006 to explore engineering students' experiences of the industrial placement. These research projects provided access to background knowledge on the issue of women engineering students, but most importantly the opportunity to collect an extensive body of data from women and men engineering students. Both of the projects were directed towards engineering students' experience of the industrial placement and the relationship between the placement and HE. The engCETL project was also particularly useful in extending the qualitative data collection to men engineering students' experiences. Some key publications from this research are Powell et al. (2006; 2004) and Moron-Garcia and Powell (2007). While there are some clear overlaps in the research, the research presented here has a much stronger focus on students' experiences of HE cultures, of career decision-making and of the role of identity, some of the research has already been published (see, Powell et al. 2007; 2009, forthcoming). Equally, it should be noted that ideas generated as a result of work towards the thesis, also helped to inform and extend the other projects beyond the scope of their original objectives. In the methodology section of this thesis, the research tools (interview guidelines and questionnaires) have been included in their entirety to aid transparency, highlighting aspects of the tools which were specific to the ESRC and engCETL projects and not this thesis.

1.8 Structure

The thesis will begin with a critical review of the relevant literature in two distinct chapters. The first, *Gendered Cultures and Identities*, addresses some of the theoretical concepts that cut through, and are both implicit and explicit throughout, the remainder of the research. The second, *Entering the Engineering Profession*, tackles existing literature on the thematic concerns of the thesis: career choice and engineering education. The latter part of the thesis will complement the literature

review, building upon, and moving forward from, previous research. The thesis details the methodology used to explore women's career choices and experiences of engineering education, including discussion of the philosophical background, sampling and access issues, methods of data collection and analysis, ethical concerns and reliability and validity of the research. Following this, the thesis will thematically present the main findings of the research, including women engineering students' career choices and experiences of HE. The chapter on career choice is particularly relevant as an empirical lens to developing an understanding of women's identities, while the chapter on engineering education is used to explore how women engineering students experience engineering cultures. The relationships between the theoretical concepts of the thesis, identity and culture, and empirical notions, career choice and HE engineering, becomes more explicit in the discussion and conclusion. Here the thesis will present the key findings and their relationship to existing literature, prior to establishing some conclusions about women engineering students' attitudes, experiences and environment in relation to their gender, identity and culture and the implications this may have for strategies and policies aimed at attracting and retaining more women in engineering education and careers. The relationship between the research questions, objectives, data collection and structure of the thesis is illustrated below in figure 1.3.

Figure 1.3 Relationship between research questions, objectives, methods and datasets and thesis chapters



1.9 Summary

- The introduction to the thesis details the context of the current research.
- It identifies the purpose of the research and its aims and objectives.
- It defines some of the key concepts that will be used throughout the thesis.
- It summarises the methodological approach to the research,
- It highlights the relationship between the current research and additional research projects in which the researchers was employed as a full-time research associate.
- Chapters two and three review the extant literature surrounding the main issues raised by the research.

2. Gendered Cultures and Identities

In order to develop an understanding of women's experiences of engineering HE and the impact this may have on their future career intentions, this thesis begins with a critical analysis of existing research in relevant areas. This chapter is focused on the cross-cutting concepts of the research: gender, culture and identity. Specifically the chapter considers how gender impacts on organisational cultures, how women experience the impact of their gender, what the prevailing cultures in engineering and academia are, how women establish and negotiate their identity and to what extent this is shaped by their position within a male-dominated environment.

2.1 Organisational cultures

Prior to addressing cultures in SET, it is useful to provide a working definition of what is meant by culture. Alasuutari (1995) states that the concept of culture refers to a 'collective subjectivity'; '*a way of life or outlook adopted by a community*' or social group (1995: 25). McIlwee and Robinson (1992) suggest that culture manifests itself through day-to-day activities and interactions. Much of the extant literature on the nature of culture refers to organisational cultures, with reference to organisations, not only as companies or workplaces, but as any group of people organised for a particular purpose. Thus, in this research the organisation is engineering classroom, where students are organised for the purpose of learning engineering. The culture of an organisation describes the unique way in which people act or interact within it (Greenwood, 1997). Smircich (1983) identifies two broad theoretical approaches. Organisational culture can be conceived, firstly, as something an organisation *has*, as something emerging from social interaction, or secondly, as something an organisation *is.* A third approach suggests that culture is something an organisation *does* to its members and society. Wajcman (1998) suggests that culture is both produced and reproduced through the negotiation and sharing of symbols and meanings. Crucially, culture is something that is *learned*; the result of mental programming (Hofstede, 2003). It is simultaneously the shaper of human action and the outcome of that process. This dynamic concept of culture highlights the limits of individuals to manipulate cultural changes, because ultimately it is not something individuals can control. Moreover, as Wajcman (1998) states, a variety of cultures can coexist within a single organisation: Brown (1995) describes these as subcultures.

In everyday terms, Martin (2002: 3) describes culture as that which has often been ignored in organisations, *'such as the stories people tell to newcomers to explain "how things are done around here", the ways in which offices are arranged and personal items are or are not displayed, jokes people tell, the working atmosphere (hushed and luxurious or dirty and noisy), the relations among people (affectionate in some areas of an office and obviously angry and perhaps competitive in another place) and so on'.*

Organisational cultures are derived from a variety of sources within and outside of that organisation. Brown (1995: 293) lists the most important of these as being: national culture, the organisation's leaders, the nature of its business activities, and its environment. The culture of an organisation is thus the product of a variety of factors; it pervades all aspects of the workplace and has a great influence on the occupational identity acquired there. Trice (1993: 46) argues that occupations have their own ideologies, which are conveyed through various cultural forms such as '*argot, myths, stories, rituals, ceremonies, symbols and physical artefacts*.' Conformity to these ideologies is required of occupational group members and is achieved through a socialisation process akin to a rite of passage.

Brown (1995: 9) further defines organisational culture as '*the pattern of beliefs, values and learned ways of coping with experience that have developed and continue to develop during the course of an organisation's history, and which tend to be manifested in its material arrangements and in the behaviour of its members*.' According to this definition it is important to emphasise the link between the culture of an organisation, informal and formal structures and the accepted/non-accepted behaviours of employees; this link is something that underlies the focus of this report. The relationship between culture and structure is two-way and complex: an understanding of this cyclical relationship is crucial in adopting a more nuanced understanding of the issues women face in entering SET professions. Writers in the field of organisational culture, such as Brown (1995), highlight the highly *cultural* nature of what is seen in such highly structured formalised spheres as the workplace, where organisations are often '*highly political miniature societies'* (Brown, 1995: xi). Thus, organisations reflect and reinforce existing societal power relationships. Similarly, McIlwee and Robinson (1992: 5) suggest that workplace culture is the medium in which gender behaviours interact with opportunities created by organisational structure.

In discussing organisational culture, Brown (1995) touches upon the potential problems particular cultural aspects may have for the individual and organisation: *'It should always be recalled that culture is not an inherently positive force in organisations. Indeed, there are organisations that possess dysfunctional cultures, which increase conflict, reduce co-*

ordination and control, increase uncertainty, diminish motivation and undermine competitive advantage' (Brown, 1995: 294). Whilst he is writing more generally about the problems a 'dysfunctional culture' may have for an organisation, an understanding of the importance of a culture that works for *all employees* and enables harmony, cooperation and greater motivation, it may be argued that a gendered-masculine culture can be increasingly experienced as 'dysfunctional' in a more progressive, mixed-gendered workplace.

The organisation can be seen as a cultural system that simultaneously promotes competition and co-operation. Members co-operate to carry out tasks, whilst competing for limited career openings (Kvande and Rasmussen, 1994). Thus, they form arenas for the power and interests of their members to be manifested (Mintzberg, 1983). Cultures, policies and processes of organisations directly and indirectly affect the ways in which employees develop their careers. This changing focus of research has resulted in the consideration of cultural, as well as structural career determinants in the organisational setting (Evetts, 1996: 33)

2.1.1 Gendered cultures

In addition to this, many academics have argued that there is a gendered aspect to culture (see for example, Hofstede, 2003; Mills, 1988). While gender can be considered as only one aspect of culture, it is also suggested that gender is fundamental to the culture of organisations, as has been shown in studies in other sectors (for example, Ledwith and Colgan, 1996; Morgan and Knights, 1991). Particular occupations are seen as gendered, in spite of changes in the gender of the people engaged in the work, because of the symbolism of the qualities needed to do the work, the activities it involves are associated with only one gender (Bottero 1992: 332). Martin (2003) suggests that key concepts associated with organisational life are related to practising gender in ways which affect women and men differently, for example, competence, effectiveness, excellence, rationality and strength. The argument here is that the behaviours most valued and rewarded in SET organisations are reflective of those traditionally associated with the masculine, rather than the feminine. As Hofstede states; '*Women are not considered suitable for jobs traditionally filled by men, not because they are technically unable to perform these jobs, but because women do not carry the symbols, do not correspond to the hero images, do not participate in the rituals or foster the values dominant in the men's culture*' (Hofstede, 2003: 16). Furthermore gendered cultures are usually pervasive, tenacious and resistant to change. Faulkner (2005a: 16) asserts that gendered

occupational culture is '*a useful concept in seeking to understand continuing gender segregation and inequality at work'*. These cultures include: shared ways of thinking and doing the job, the language and symbols used, formal and informal social interactions. Wajcman (1996) argues that the bond between hegemonic masculinity and engineering lies in the social construction of engineering as a masculine issue in the polarisation female/male. Hegemonic masculinity is the form of masculinity most highly valued in a given society (McLean et al., 1997; Connell, 1995) and in western society is epitomised by white, middle class, heterosexual men. In the advanced industrial world, and especially in SET sectors where scientific and technical rationality are highly valued, associations with women as more emotional, less analytical and weaker than men, play a powerful role in the ideological construction of women as inferior. When women enter spheres where masculine culture dominates, it is argued that they experience 'culture shock' (Hofstede, 2003).

Itzin (1995) characterises gender cultures as hierarchical; patriarchal, sex-segregated; sexually divided; sex-stereotyped, sex-discriminatory, sexualised, sexist, misogynist; resistant to change; and with gendered power structures. The combination of these features forms a workplace where masculinity is a dominant element of corporate culture (Hofestede, 1984). In attempting to define the prevailing organisational cultures under which women are subordinated in local government, Maddock and Parkin (1993; 1994) developed the conceptual typology shown in figure 2.1. The extent to which these different cultures exist in engineering education will be explored throughout this research.

Figure 2.1: Organisational gender cultures

Name of Culture	Key Features of Workplace Environment
The Gentlemen's Club	Women are seen as homemakers, men go to work. Most women cannot challenge it and so accept such attitudes.
The Barrack Yard	In hierarchical structures (such as military organisations) with many layers of management. A bullying culture where sub-ordinates are ignored. Women and part-timers work in junior posts find it difficult to progress
The Locker Room	An exclusionary culture where sexual references are made to confirm male heterosexuality. White male bonding through sport and sexual innuendo is rife. Women with power are treated the same as junior women.

The Gender Blind	This makes no reference to an employees home-life or personal circumstances, thereby assuming a level playing field for all employees
The Smart Macho	Economic efficiency is sought at the expense of personal need. Those who cannot work long hours and sacrifice family lives do not achieve.
The Paying Lip Service	Men think they are not sexist, are well versed in feminism and define themselves as an equal opportunities (EO) employer. However, they do nothing to promote women or minorities.
The Women as Gate-keepers	Resistance to women managers comes from other women employees with different career/family orientations.

Source: Maddock and Parkin (1994)

2.1.2 Engineering cultures

The central role of engineering in society and the economy is not evident to the public at large nor to the media in particular. The National Academy of Engineering (2004) in the US depicts key attributes of an engineer as someone with analytical skills, practical ingenuity, creativity, communication, business and management, leadership, high ethical standards, professionalism, dynamism, resilience, flexibility and life-long learners. Metz (2007) suggests that none of these attributes are 'inherently masculine', and should attract a wide spectrum of people. However, the fact that women remain under-represented in engineering, as shown in the *Introduction* in chapter one, indicates either that popular perceptions of engineering are inaccurate or that engineering discriminates against women in other ways. Hatch (2006), for example, states that although engineering plays a critical role in society, the job of an engineer remains a mystery to many people outside of the profession. Sagebiel (2003), on the other hand, argues that women are driven away from technology by the prevailing content and climate, which construct an atmosphere of dominant masculinity.

The engineering profession is, according to Malpas (2000) considered by many as a somewhat dull, uncreative activity, associated with the so-called 'old-economy'. Historically the image of engineering has been tough, heavy and dirty and to do with machinery. In terms of cultural image, engineering is perceived as a masculine profession. These cultural images have remained powerful and have helped to reproduce the perception that engineering is unsuitable for women (Evetts, 1998). This is a somewhat cyclical process, reinforcing the masculinity of the industry. It is argued that

this is a result of the polarised characteristics supposedly attached to gender in the process of socialisation. Sagebiel (2003) states that engineering can be considered gendered in three ways. First, gendered structures are visible in gender difference in the division of labour and in the work styles of women and men. Second, the symbols and images of engineering knowledge and practice are gendered through cultural associations between masculinity and technology. Third, individual engineers have gendered personal and professional identities and experiences.

It is also the case that women suffer if they go against such cultural dictates (Evetts, 1998). This is supported by Glover et al. who report that previous research indicates "women actively choose not to enter SET, in the knowledge that they are likely to feel 'cultural discomfort'" (1996:66). This is because when women undertake 'male work', they upset a widely accepted sense of order and meaning (Cockburn, 1985). Although women can cope with the actual engineering work, they are likely to find it much more difficult to cope with the engineering culture (Evetts, 1998). Some women therefore pay both personal and social costs when they cross the threshold into a male domain. Opportunity 2000 (1996) suggests that this is because young women in science and engineering, for example, find themselves working with the values, systems and performance criteria which have been set up by men for men, and not for women.

By contrast, Bennett et al. (1999) claim that women who seek a career in the construction industry are socialised into its culture through the education system and appear actively to seek that culture. Gale (1994) describes gender values as a continuum ranging from male to female and suggests that women holding similar values are attracted to similar occupations. Bennett et al. (1999) do, however, concede that the reverse is also true: many women reject the construction culture as unacceptable, as do many men. Gill et al. (2008), for example, found in their research that in general the men engineers were in agreement with the women informants about certain aspects of the shared culture which they too experienced as very macho, male-dominated in style and content. However, while men may face some similar difficulties to women regarding engineering cultures, Madhill et al. (2007) suggest that for women these concerns are underpinned by a perception that they face these issues because they do not 'fit'. They suggest that women may cope with this by ignoring gender and attempting to show they are not 'different'.

2.1.2.1 Women's sexualisation

There is a key issue of *(in)visibility* for women in professions dominated by men, such as in engineering, where they are perceived as women first and engineers second (Faulkner,

2005a, 2000a; Womeng, 2006). Cockburn (1991) suggests that this may be because some men employees have difficulty relating to women other than as sex objects or domestic carers and can have particular problems with women who do the same job as they do. As women, by biological definition, can never be men the sexualised cultures that are expressed within SET organisations are a key force that works against their acceptance in these professions dominated by men.

Women in SET professions are careful about how they present their bodies in the workplace and often struggle to find the right balance between being a SET professional and being a woman (Evetts, 1994; Faulkner, 2006). The visibility of being a woman in SET organisations dominated by men can be uncomfortable (Powell et al. 2004). Similarly Carter and Kirkup found that women engineering students noted a heightened visibility or 'conspicuousness', which resulted in women feeling they were under constant evaluation and could rarely *'relax and merge anonymously with the mass'* (1990: 66; see also Walker, 2001). Carter and Kirkup (1990) found that this phenomenon continued in the workplace, also suggesting that it can have a positive impact, where women may develop a reputation faster than their colleagues. For example, being in a minority means that women 'stand out from the crowd', and may be remembered more than their male colleagues. However, this can also have a negative impact, particularly if women are remembered for making a mistake for instance.

Carter and Kirkup (1990) also indicate that women engineers felt the need to project an appropriate 'image' of a professional. McIlwee and Robinson argue that to be taken as an engineer is to look like an engineer, talk like an engineer, and act like an engineer, '*In most workplaces this means looking, talking and acting male'* (1992: 21). As a result, Carter and Kirkup argue that *'the rules for male dress do not make a statement about the gender and sexuality of men in the same way as they do for women'* (1990: 79). While, on the one hand, women attempt to become more like men in order to be accepted as SET professionals, on the other hand, women must also project their femininities, 'since being a 'masculine' woman would be even more unacceptable to their male colleagues' (Carter and Kirkup, 1990: 82).

Gill et al. (2008) suggest that being part of a female minority emerged in their research as a tipping point around which the women engineers took up differing positions. For instance, women participants responded in divergent ways when asked about the experience of being a minority as a woman engineer. For some the response was to downplay the 'female-as-different' position and to insist on equality as sameness with the men whereas for others it was a case of recounting their experience of being made to feel

different and 'other' as woman and working out ways of using this position to achieve a degree of comfort in their workplace.

This is also similar to what Sheppard (1989: 146) describes as a strategy of 'blending in and claiming a rightful place'. Sheppard found that 'blending' depended on careful management of being feminine enough in terms of appearance, self-presentation, acceptance of different expectations and of motherhood responsibilities, while at the same time being business-like enough (competent, desiring promotion to a point and in particular directions), in order to claim a rightful place in the organisation. In addition, Schmitt et al. (2003) argue that conforming to organisational norms and displaying behaviour typically associated with men may be necessary to avoid stereotypical performance expectations based on one's sex. However, this strategy can also backfire, as women who conform to traditional masculinist work roles may be penalised for not being 'womanly enough.'

Also the dominant heteronormative masculinist cultures in SET organizations are often starkly expressed through the objectification of women and their bodies; this may be through use of language or imagery that focuses on sexual aspects of women's bodies. This type of discourse is often experienced as uncomfortable for women, regardless of their acceptance or rejection of it. The *sex* of women undermines women's professional place in organisations dominated by men, such as those in SET. In their study of women engineers in the UK and US, Carter and Kirkup (1990) found that women HE students were not taken seriously by men students; rather it was assumed they were studying engineering in order to find a husband. Similarly, Walker (2001), from her study of women and men studying or researching Electronic and Electrical Engineering in a Scottish university, documents women's perceptions that men *'can't just see you as a friend. There's always got to be a hidden agenda'* (2001: 83).

While it could be argued the different sub-cultures exist across the engineering sector, Gill et al. (2008) argue that there is sufficient evidence to support the claim that there are striking similarities in women engineers' experiences across different types of engineering, including building, aerospace and environmental engineering.

2.1.2.2 Language and humour

A key cultural aspect of the ideology of the masculine sciences is expressed through language. Faulkner (2006) also suggests that use of the 'generic he' to refer to engineers means that women engineers are both invisible and a non-entity. Frehill (1997) found, in her US study, that women engineering staff in HE reported that students more often called

them by their first name or used titles like 'Miss,' 'Ms' or 'Mrs', rather than 'Professor' or 'Dr'. Women engineering professors have also reported that students often asked about their engineering credentials or appeared more critical of in-class mistakes. McIlwee and Robinson (1992), in their US study of women engineers, also describe women's irritation at being called 'Honey' and 'Sweetie'. They suggest that this behaviour can be considered a form of sexual harassment, undermining women's professional status and reinforcing men's views of women as merely sexual beings. Similarly, Faulkner (2005b) maintains that while many would probably argue the issues described above are 'only words', they send powerful subliminal messages to both women and men. Conversely, Faulkner (2005b) suggests that some non-work conversations she witnessed in engineering companies was wide-ranging and inclusive, even where there were few women, although she does acknowledge that the more diverse a workplace, the more wide-ranging conversation topics are.

The issue of language in SET is particularly epitomised through the use of humour. Numerous research studies have addressed the teasing and joking faced by women in SET (see for example, Carter and Kirkup, 1990; Faulkner, 2005b, 2006; McIlwee and Robinson, 1992; Powell et al., 2004; Womeng, 2006). Furthermore, such research exposes that women 'feel they can handle it,' and claim to see it as 'all in fun'. Watts (2007) found that for women civil engineers, humour has three key effects: humour as resistance to dominant power structures, humour as social refuge and humour as a social exclusion mechanism. Humour as resistance refers to women's use of humour to resist challenge to their authority, although not always deliberately. Humour as social refuge refers to women engineers' exchange of office gossip with secretarial staff (almost always women) and the light-hearted office banter intended to forge good working relationships.

Whilst Faulkner (2006) points out that both men and women engineers can feel discomfort with 'dirty' humour, however such behaviour is generally something that men do not have to deal with. Furthermore, men and women are deterred from challenging offensive humour by the perceived risk of alienating themselves from their men colleagues and, as a result, will often join in regardless (Faulkner, 2005b, 2006). However, Faulkner (2005b) also witnessed engineers 'self-policing' and women challenging others for being potentially offensive.

Lyman (1987) studied jokes to examine how masculine cultures emphasise differences between men and women. He views jokes as '*a theatre of domination in everyday life, and the success or failure of a joke marks the boundary within which power and aggression may be used in a relationship*' (1987: 150). Frehill (1997) suggests that jokes

are one way of reinforcing the boundary between engineers (the adept) and non-engineers (the inept). When ineptness is equated with women, a boundary between engineers (men) and women is emphasised. This is supported in the wider literature about humour in the workplace. Holmes (2000), for example, states that while humour can be used to reduce inequalities, it is also used to emphasise or reinforce power relationships. Holmes also indicates that humour can be used implicitly as a way of 'doing power', *'humour can be used to achieve the speaker's instrumental goal while apparently de-emphasising the power differential'* (2000: 165). McLean et al. (1997) support this stating that sexualised and sexist jokes work to undermine women by emphasising that women are inferior and do not really 'belong'. Holmes goes on to state that humour is a means of embedding risky or unacceptable behaviour in superficially harmless statements, thus allowing the dominant figure to maintain authority while continuing to appear friendly. This factor may account for women's documented acceptance of workplace humour in SET. Interestingly, there is little evidence in the SET literature of the use of humour by women to subvert overt power structures, a phenomenon which Holmes describes as 'contestive' humour.

2.1.2.3 Gendered stereotypes of engineers and women

Clear stereotypes exist within the SET professions relating to women's job performance and future potential, in particular, because of the dominant association between traditional notions of masculinities and technology (Cockburn, 1985; Faulkner, 2000b). A finding that complements the resonance of traditional and essentialist notions of gender communicated in common sense discourse is described by Powell et al. (2006) where it was implied that women engineers are different from 'normal' women. In engineering, there are clear distinctions made between 'real' engineering (technicist) and other work in the sector (Faulkner, 2005a) often utilising the conceptual framework of the masculine/feminine continuum discussed earlier with regards to preconceptions of SET professions. Presumptions are made about the hands-on 'tinkering', technical abilities of professionals, as highlighted by Lewis (1995) with regards to HE, which continues to play a key cultural role in some SET organisations, particularly within engineering. Tinkering forms an important membership issue in how one belongs (Faulkner, 2005a) and is part of the deeply gendered occupational cultures that exist in engineering. Faulkner (2000b) also highlights how dualisms endure despite their multiple contradictions.

2.1.3 Academic cultures

Given that HE engineering cultures are likely to combine elements of academic cultures as well as engineering workplace cultures, this section is focused on exploring the nature of existing cultures in academia. Deem (1996) argues that educational organisations are both like and unlike other organisations. Like other organisations they provide a service, employ people, have their own rules and resources, and require managing. However, their purpose and goals may be less clearly defined. While teaching and learning are central activities, there is also a wider range of goals (for example, developing social skills, passing exams etc.). Educational organisations may also be distinctive in that many attempt to transmit values of humanism (for example, valuing people for themselves) although in reality this may not always be the case.

The Hansard Society Commission Report (1990) describes British universities as male bastions of privilege and power, and women's chances of entry, promotion and retention are generally lower than men's. Morley (2000) argues that academia maintains its gendered power relations through everyday practices such as bullying, stalling, sabotage, manipulation and spite. Such occurrences appear trivial, subtle and difficult to capture, but at the same time they reveal the ways in which competition and domination are played out. According to Morley, the study of micropolitics within the academy can illuminate ways in which organisational power accrues. Even in countries that are considered to be at the forefront of promoting gender equality, such as Finland, women still encounter subtle forms of discrimination (Husu, 2001).

Bebbington (2002) suggests the pattern of attrition (the further one goes up the hierarchy, the fewer the women) persists in all disciplines including business, social studies and language-based studies. There are nevertheless disciplinary differences, with women best represented in language-based studies at almost every grade and worst represented in engineering and technology.

Bagilhole and Woodward (1995) show that sexual harassment is an under-recognised and underestimated phenomenon in the UK academic profession and a strong indicator that the problem lies with the academic culture. Morley (1999) argues that employment issues are highly linked to epistemology, with discrimination against women perpetuating and upholding the male perspective in academia.

2.1.4 Higher education and curriculum

Bagilhole and Goode (1998) write that research on the operation of gender factors in the educational curriculum have been mostly school based. While, in the HE sector, '*equal opportunities … is seen very much as an employment issue, and not as an issue which relates to the delivery of educational courses and research*' (Davies & Holloway, 1995: 13). This is a serious omission because, as Weiner explains, the curriculum is '*of crucial interest because it highlights and problematises taken for granted assumptions about knowledge, gender and culture … it is socially constructed and as such, is both a reflection of dominant ideas and a place where these ideas are played out or resisted through practice*' (1994: 3-4). However, there are some exceptions. Thomas (1990), for example, looked at the relationship between the 'culture' of certain subjects and how women and men students related to them, exploring gender relations in the context of specific curriculum discourses and practices. She found that women science students saw themselves as a homogeneous group that was different and uncomfortably visible in 'a masculine preserve'. Evans (1995: 73) argues that because '*control, rather than consumption [of the curriculum], is in the hands of men … the very assumptions of the academy – its claims to universal and generally applicable knowledge – have to be challenged*'. Bagilhole and Goode suggest that male academics have defined not only what is taught in universities, but also how it is taught, in a way that marginalises women.

Re-evaluation of curricula is now underway. However, Bagilhole and Goode have found that changes in the actual practice of curriculum design, staff-student interaction, and assessment, are slower and more patchy in traditional institutions of learning, such as old universities, where questions of epistemology and pedagogy have gone largely unexamined. They suggest that the innovations now taking place in universities seems to have come from three directions. Firstly, equal opportunities specialists are now beginning to undertake equal opportunity audits of the curriculum. Secondly, where women scholars are themselves represented, *completely new curricula* have appeared as a result of feminist endeavours. Thirdly, in the traditionally male-dominated science and engineering disciplines, concerns have centred around *access to subjects* where women's representation is poor.

Bagilhole and Goode (1998) also found that individuals could operate either a 'narrow' or 'broad' definition of the curriculum. The curriculum might be taken as simply referring to the topics to be covered in a particular course or module, rather than the whole process of

teaching and learning and all the activities in their various contexts which take place during that process.

Whyte (1986) and Kelly (1987) suggest that gender related differences between subjects can be instilled both by the content of the subject and by teaching styles which consciously try to appeal to one gender. Some subjects may thus appear culturally neutral, but the way they are taught may be organisationally and pedagogically gendered (Deem, 1996). Walker (2006) reinforces this when she writes that teaching and learning methods act as a conveyor for relations of power and privilege.

The nature of academic cultures and curriculum is further explored in relation to engineering in chapter three, sections 3.2.2 *HE engineering cultures* and 3.2.3 *Curriculum content.*

2.2 Identities

Although organisational cultures will play a significant role in shaping women engineering students' experiences, it is also important to consider how women perceive their own gender and identity and its impact on their experiences, as well as how women adapt (or not) to organisational cultures that prevail in engineering, and what consequences this may have.

Ford (2006) writes that the debate on the meaning of identity has two main strands. The first strand, social theory, conceptualises identity as 'self-identity'. One of the main theorists here is Giddens (1991) who argues that identity is the individual's conscious sense of self. The second strand, poststructuralism, deconstructs identity recognising the *"the significance of context and the role and power of discourse in shaping organisational and social practices"* (Ford, 2006: 79). In this sense, identities are fluid and constantly negotiated based on our subject position (Ford, 2006) and that of others. Lawler (2008), for example, argues that how an individual identifies themselves, may not be how other people identify them (for example, the individual may identify as a 'woman', while other people identify them as a 'girl'). It is therefore possible for individuals to occupy multiple subject positions and identities (Collinson, 2003) and that at times these identities may be in tension with one another (for example, 'mother' and 'worker'). It is also feasible that individuals will emphasise different aspects of their identity at different times and places. Thus Bruni and Gherardi (2002) indicate that individual identity is not fixed, but rather it is constructed through enactment and performativity (Butler, 1990). Furthermore, McLean et

al. (1997) suggest that identity is not usually a conscious process, which means that the ideas individuals hold about themselves can be contradictory and inconsistent.

2.2.1 Managing gender

West and Zimmerman (1987) suggest that men and women 'do' gender in social interaction, despite perceiving that they act in gender free or gender neutral ways. Since people bring their beliefs about gender into social relations with little thought, gendered performance is pervasive and taken for granted (Ridgeway, 1997). While participants in organisational culture may believe they express personal taste and inclinations, Gherardi (1994) maintains that knowledge of what fits with the organisational style is an acquired skill. Gherardi therefore argues that the way gender is 'done' in work can help diminish or increase inequality between the sexes. Added to this, Butler (2004) implies that doing gender can result in being undone. For example, women may perform their gender in a particular way in order to gain male acceptance, but this, in turn, may implicitly devalue femaleness. In other words, the terms on which women are accepted as fitting into an organisation, may make their lives unliveable, yet the option of not fitting in or being recognised may also lead to a life not worth living.

In addition, second-wave feminisms have elaborated and problematised gender as a concept to mean more than a socially constructed binary identity and image. The modern feminist usage of gender, as distinct from sex, is most clearly articulated by Simone de Beauvoir (1949) who concluded that it is not biological, psychological or economic factors that shape the prescribed difference between men and women, but rather, 'woman' is socially constructed as the 'other'. Gherardi (1994) suggests that in the classical binary positions of Western philosophy, the interdependence of terms is hierarchical. The first terms are treated as superior and the second as derivates. Individuals are therefore trapped by a process of binary opposition, whereby what is affirmed with one term, is negated with the other. Butler (1990) maintains that the ramifications of Beauvoir's deconstruction of gender are more far-reaching. Not only does the separation of sex and gender loosen the restrictions on social roles, but also insinuates that there are different sorts of being. This implies that a certain sex does not necessitate a certain gender, although there are powerful cultural constraints (Cole, 2000). Thus, those beings categorised as female need not aspire to, or need not be the only one to aspire to, 'womanhood'. According to West and Zimmerman (1997: 126) gender '*is the activity of managing situated conduct in the light of normative conceptions of attitudes and activities appropriated for one's sex category*.' In other words, gender is something people think,

something they do and something that they make accountable to others. '*Doing gender involves a complex of socially guided perceptual, interactional and micropolitical activities that cast particular pursuits as expressions of masculine and feminine natures*' (West and Zimmerman, 1997: 126). Thus gender is not a simple property of people, but an activity and social dynamic.

Gherardi's (1994) research findings exemplify Butler's (2004) notion of what it might mean to undo restrictively normative conceptions of gendered life. While a normative conception of gender can undo an individual's personhood, undermining the capacity to persevere in a liveable life, the experience of becoming undone can also undo a prior conception of who an individual is only to inaugurate a relatively newer one that has greater liveability. Thus, while women are becoming undone in a good way, and breaking barriers about womanhood, by entering male-dominated arenas, they are simultaneously becoming undone in a bad way, as a result of disqualifying their gender in order to be successful in that arena. Similarly, Meyerson and Scully (1995) suggest that some individuals do not easily fit within the dominant cultures of their organisations or professions. These individuals, in this case women in engineering, must continuously manage the tension between personal and professional identities that are at odds with one another. Some individuals cope with this by leaving the mainstream, while others may silence their complaints and surrender their (female) identity.

Gherardi (1994) maintains that doing gender is essentially getting to grips with an ambiguity that, scientifically, we lack the instruments to cope with. Our experiences of managing and building gender are characterised by contradictions and double-bind situations (for example, where women who are considered feminine will be judged incompetent, and women who are competent as unfeminine), by ambivalence and uncertainty because these are the constitutive elements of the opposition between male and female and their intimate indivisibility.

As Gherardi (1994) points out, the multiple contradictions and ambiguities, make 'doing gender' difficult to deconstruct. In order to make sense of these findings, rather than perceiving gender as bipolar, it is useful to perceive of multiple masculinities and femininities. While this idea has been critiqued for leaving the gender divide in place (Linstead and Brewis, 2004), its use here is not intended to reproduce the hierarchical divide between masculinity and femininity, but rather, to provide a framework that allows researchers to explore the 'doing' and 'undoing' of gender. In this sense, the construction of 'men' does not accrue exclusively to the bodies of males or that 'women' will interpret only into female bodies (Butler, 1990). Individual women combine traditional perceptions

of both masculinity and femininity. Thus women engineers are neither 'typically' feminine nor 'typically' masculine.

It is also important to note that different masculinities and femininities will be adopted and performed, both actively and subconsciously, at different times by individuals. Sinclair (2005) argues that women may well prove to be bi-gendered in their approach. That is, they learn an array of influence tactics depending on the context, who they are working with, how much power they have and whether influencing upwards or downwards. This goes someway to explain the apparently contradictory attitudes of women engineers in this research. For example, at one given time it may be necessary for women engineers to 'achieve a reputation' as a competent engineer, but at another women will accept offers of help from their male colleagues. While these are very different strategies, they both have the same aim: to gain acceptance. Thus the women engineering students were found to perform their gender in a number of ways as part of their assimilation and professionalisation into the engineering industries, but also for themselves, because '*we create and reinforce our gender identity by the performance we put on*' (Paechter, 2001: 50).

2.2.2 Gender conscienceness

Other recent literature has discussed gender conscienceness. Volman and Ten Dam (1998) discuss how gender equality rather than gender inequality, has become the norm in Western society. In theory at least, women have the same rights and opportunities as men. Rich (2005) suggests there is a growing literature exploring how young women are taking up or resisting feminist discourses, *'particularly in relation to their lived experience of gender'* (2005: 495). Budgeon (2001) indicates that while women can be alienated from and by second wave feminism, their identities can, at the same time, be intrinsically informed by feminist ideals. Similarly, Rich (2005), in her study of young women and sport, found that many of the women she interviewed had characteristics that might be associated with young feminists: they were confident, ambitious, determined to challenge inequality and had all entered traditionally masculine domains. Yet, the women also sought to distance themselves from a feminist position. She found that the choices women were making were largely dependent on social conditions that had been challenged and restructured by feminist principals of equal opportunities. They all shared a belief that women were free and equal with men to enjoy equal opportunities in practice.

However, while there may be some merits to adopting such an individualist approach, Rich maintains that it also obscures structured and socio-cultural gendered inequalities,

impacting on the way women themselves realise gender binaries and distance themselves from feminism. Volman and Ten Dam (1998) suggest that this position is the result of contradictions in gender identity, where gender inequality is considered a past phenomenon, and that participation in a feminist discourse carries the risk of being perceived as a 'victim', a negative identification that young women seek to avoid. Rich (2005) shows that this illustrates the complex processes that women have to negotiate in different ways. This positioning has been referred to in the literature as popular feminism (Skeggs, 1997) and 'do-it-yourself' feminism (Bail, 1996), whereby women do not define themselves by a collective gender affiliation, but by individual or 'personal challenges'. Budgeon (2001) suggests that these 'postfeminist' views have been criticised for creating *'a false impression that equality has been achieved'* and encouraging *'young women to pursue their individual freedoms at the expense of a collective female identity … problems that young women encounter in achieving their goals are constructed as individual problems and not political ones'* (Budgeon, 2001: 13).

However, Rich (2005) also found that this position can result in *'an obvious disdain for other women or girls who might be perceived as weak, or who 'failed to exercise individual choice''* (2005: 502). Thus, Rich goes on to state that on the one hand, women do not account for the gendered structures that might prevent 'girlie-girls' from taking part in sport, and rest blame for their lack of participation on the individual. However, by drawing on language like 'girlie-girls', 'slappers' and ideas about femininity and passivity, they implicitly invoke gendered binaries: *'they come to interpret these girls and their relative sense of self along familiar gendered storylines'* (Rich, 2005: 502). The women in Rich's research also described experiences of 'gender role maintenance' whereby others around them policed their femininity through peer acceptance or rejection, and alluded to the consequences of being relegated to 'gender margins' (for example, women in sport are often believed to be lesbians). As a consequence, women are active in maintaining certain aspects of their femininity, concerned that they might lose legitimacy to feminine identity. Furthermore, while these women may be 'blind' to some of the inequalities they face (Martin, 2006, for example states that subtle forms of sexism and bias are rarely recognised), the individualist position prevents them from challenging constraints. Budgeon's (2001) research indicates that while young women recognise and maintain that gender inequality is still a significant issue, they tend to attribute responsibility for a solution to individual women, rather than identifying with the political collective 'women'. Rich (2005) concludes that while individualism may offer women positions that were previously denied to them, it also constrains what they might become and how they might practice 'resistance'. She suggests that young women draw upon discourses at different

moments in constructing a sense of self and identity and in 'choosing' how to live their lives. In other words, women are constructing a sense of self as autonomous and free to choose, but at the same time their gendered sense of self and choices are relationally positioned within and against other discourses. This is similar to Martin's (2003) argument that it is necessary to consider whether people practice femininities or masculinities because they want to or because situations call for or require particular practices.

2.2.3 Gendered identities in engineering

Faulkner's (2005a) discussion of gendered processes in engineering raises some interesting points with regards to the socialisation processes that women (and men) experience and how these processes affect gender performance in the workplace. She argues that the occupational cultures communicate a clear way of 'becoming and belonging' as an engineer that often brings to the fore the question of gender authenticity that hangs over women engineers. Similarly, Womeng (2006: 66) found that much of women's '*energy goes into rituals of adapting to the male environment and culture'*. Bjorkman et al. (1997) found that women computer scientists in Sweden experienced a conflict between their gender and professional identity.

Miller (2002) suggests that the strategies women develop to survive often involve adapting to the dominant masculine cultures, rather than trying to change or challenge it. Evetts (1996) maintains that 'strategies' describe the way individuals cope with, negotiate and manage cultural expectations and structural processes. She states that '*the concepts of 'strategy' and 'identity' have been suggested as ways of emphasising the actions, experiences and choices of women, as well as men themselves and of incorporating cultural and structural processes, as constraints that have to be managed, in the subjective career'* (1996: 20).

Miller (2002) suggests that the assimilation strategy used by the majority of women in her research was similar to what Marshall (1993) describes as 'muted', in that '*there is an unawareness of the masculine nature of the context'* (Miller, 2002: 157). Thus, women learn both during their professional training and in their work context what types of behaviour are rewarded. Madhill et al. (2007) also argue that women learn to adapt to gender differences. They add that even women who recognise the systemic nature of the issues they face adopt individualistic strategies in order to survive. However, Miller highlights the fact that while women can learn masculine rules and behaviours, they cannot directly mirror them, because ultimately they will still be women. Thus, while the coping strategies adopted by women may be extremely successful on a short term,

individual basis, they serve to reinforce the gendered system, leaving little hope for long-term change (Miller, 2002). Numerous research studies indicate that women who seek entry into cultures dominated by men either have to act like men in order to be successful, leave if they are not adaptable to the cultures, or remain in the industry without behaving like men but maintaining unimportant positions (see, for example, Bagilhole, 2002; Bennett et al., 1999).

Whittock (2002) proposes that there are two ways then in which tokens can respond to 'boundary heightening'. Accepting isolation risks exclusion from occasions on which informal socialisation, and sometimes, political activity, takes place. Conversely, women can attempt to become an insider (or 'one of the boys'). Assimilation is described by Kanter (1977) as the way in which dominants distort the characteristics and behaviour of tokens to fit their stereotyped images of how token women should behave. Token women can object to this, or accept some form of 'role entrapment' by adopting restricted and often caricatured roles within the system, e.g. 'the mother', who is empathetic, a characteristic to be utilised 'on the job'.

Carter and Kirkup (1990) found that women engineers' sense of identity was individual, rather than as a member of the female sex (see also Madhill et al., 2007). As such, women took greater pride in being 'engineers' as opposed to 'women engineers'. This may also be part of the process Dryburgh (1999) calls 'professionalisation', which entails learning the appropriate theory and code of ethics, associating with the professional regulating body, and adjusting to or internalising the values, norms and symbols of the professional cultures. Miller (2002) also found that Canadian women engineers conformed to beliefs and values consistent with a masculine value system. Accepting traditionally masculine values was seen to be key to success both in engineering and in their organisations. In their study of women sports journalists (another male-dominated arena), Hardin and Shain (2006) found that women will often attempt to become 'one of the boys' and adopt masculine values and practices. The women may 'normalise' existing cultures, refuse to acknowledge, or are blind to, the disadvantage(s) that women face as a group, and may even blame other women for their own subordination. Furthermore they suggest that through professional socialisation, the authoritarian power structures that exist in the field are idealised, with the result that many women resist taking '*a political stance on women's issues'* (Hardin and Shain, 2006: 326).

In some instances this may result in a reluctance to associate with other women. McIlwee and Robinson (1992), for example, found that women did not want to be mistaken for 'feminists' or as hostile to men and as a result they sometimes spoke disparagingly of

other women and were reluctant to identify with other women. Sinclair (2005) suggests that this so-called 'Queen Bee' syndrome may simply be a result of women in SET becoming accustomed to an environment dominated by men through technical hobbies, and the choices they have made in education. Whatever the origins of masculine-identification, Sinclair goes on to say, '*these women enjoy the company of men, share interests and aspirations that are typically characterised as masculine, and perhaps seek their approval'* (2005: 139). Hardin and Shain (2006) also conclude that it cannot be assumed that women will incorporate a feminist agenda as part of their professional identity. Such attitudes fail to question the status quo. Any career success among such women is unlikely to promote the interests of women in the sector generally (Greed, 2000). It also raises questions about the concept of a 'critical mass': the idea that once there is a sufficient proportion of women in engineering, the traditionally masculine cultures will no longer prevail. Williams and Emerson (2001), for example, suggest that if women account for at least 30% of the workforce the existing cultures may be challenged (see Powell et al. (2006) for further discussion of critical mass). This was also shown in Küskü et al.'s (2007) research with engineering students in Turkey, where gendered prejudice was found to persist despite women accounting for 35% of engineering students. As Sinclair points out, by the time women achieve positions of formal power, they have learned and share similar influencing strategies to their men colleagues: '*they have become enculturated'* (2005: 110).

However, the women in Miller's (2002) study still described feeling like an 'outsider'. She suggests that this feeling of difference is not rooted in women's occupational or organisational values, beliefs or behaviours, since these are often consistent with the masculine systems. That they still felt, at times, fundamentally outside the norm testifies to the absoluteness of the general belief in a binary gender system. Miller concludes that while it is argued that gender is socially constructed and separable from primary sexual characteristics, this has little effect in reality. In spite of women engineers destabilising gender roles by acting 'like men', at some point the salience of the perception that they are women takes precedence. Similarly, Hardin and Shain (2006) discuss the idea that, despite the tension between the two positions, women in sports journalism are simultaneously 'outsiders' by virtue of their gender, but 'insiders' by virtue of their adherence to the dominant norms and values.

Dryburgh (1999) argues that assimilation is actually a process of professionalisation by engineering students (women and men), which requires adaptation to the professional cultures, internalisation of the professional identity and solidarity with others in the

profession. Faulkner (2006: 4) suggests that in 'learning the job', engineers are socialised into the occupation and the company, '*they must learn to be (or behave as) particular kinds of people'*. For women, the success of cultural adaptation, may also include the management of their own gender. Dryburgh maintains this is likely to include defining sexist behaviour as exceptional, working hard to show solidarity with men colleagues and accepting uncritically the masculine cultures into which they are entering. This is also linked to Goffman's (1959) concept of 'impression management', whereby a range of actions are used to project an impression of self that the individual hopes will elicit a desired response or reaction in others. Similarly, those who do not conform to the cultural values and norms of the engineering profession, will be weeded out from an early stage (Dryburgh, 1999). However, Dryburgh does state that participation in the cultures and activities of engineering are not as important as women conveying the impression that they are not a threat to the traditions of masculine cultures.

Walker (2001) found that women engineering students were often either ambivalent or rejected gendered explanations of their experiences. She suggests this is a result of normalisation, rather than sex equality, and that women have an investment with dominant hegemonic masculinities: *'young women claim to be strong enough to handle their male peers, matching even their social behaviour. But in doing so, they arguably sustain dominant versions of masculinity'* (2001: 83). Furthermore, the perception that the only thing that matters is the ability to 'do the job' (and not sex), is in contrast and conflict with many other experiences and attitudes described by women working and studying in SET. Hardin and Shain (2006) found similar evidence of women sports journalists downplaying situations that made them feel uncomfortable, accepting it as 'par for the course' and resisting the view that certain behaviours can be characterised as sexual harassment. However, as Martin (2003) argues, if people believe that behaviour is not gendered, often because of a lack of reflexivity, they can deny gendered behaviour exists, even if others see or experience that behaviour as gendered.

Gill et al. (2008) discovered that women engineers' sense of being unique was reflected strongly in their research. Most of the women understood themselves as unusual, different, not fitting in, 'not your average woman' – a situation that was a source of pride and at times gave rise to a sense of isolation. In fact they suggest that women engineers become what other researchers have identified as a 'conceptual man' (Ranson, 2005).

Gill et al. (2008) also suggest that many of the women operated along a continuum between two seemingly opposite positions as they negotiated their identities as engineering professionals and workplace colleagues. One such position was to

consciously opt for the position of engineer, where the idea of being a woman was in total opposition to the concept of being an engineer. These women disavowed their womanhood in a quest to be equal and accepted as legitimate. There was also a need to establish themselves as capable of doing the job, so that '*the whole female thing just disappears*' (Gill et al., 2008: 230). They suggest that women who positioned themselves as 'one of the blokes' took on a male persona in the effort to be accepted with some measure of legitimacy and sense of belonging. For others the situation was less clear-cut and their professional identities were subject to ongoing negotiation in terms of positional power and gender. Many of these women claimed an 'odd one out' status, but appeared to both reject the idea of gender being a problem and at the same time acknowledge that having more women around might be conducive to a more comfortable work environment. Previous research has noted that women in male-dominated occupations such as engineering tend to resist positioning themselves as women and different, fearing the loss of professional identity in so doing (Dryburgh, 1999).

Women engineers at the other end of the continuum appeared to enjoy being treated by the male workmates as special simply because they were women. They adopted a role that allowed their male colleagues to treat them as 'daughter', 'wife' or even 'mother'. In this case recognising and claiming minority status can be a two edged sword in that, while the female presence is acknowledged, the perception of difference is confirmed which further denies the possibility of professional recognition.

In adopting particular positions, Gill et al. (2008) suggest that women are compelled to either deny or over-emphasise their femaleness. They are engaged in constant negotiation of their place in terms of being a professional engineer and being a woman. The women who become 'one of the lads' can obtain some professional identity but at the cost of sacrificing any sense of feminine subjectivity whereas those who took on the 'pretty woman' role effectively negate their professional identity as they take on a position constructed by and dependent on male responses. Women engineers struggle to construct a space in which they can be individually acknowledged as both woman and professional engineer. Neither of these positions troubles the dominant gendered power relations of the workplace – and in fact can be seen to reinforce the gender dynamic. Further, while their education constitutes the women as high fliers and individual achievers, it has not provided them with the skills to get along in the workplace or to operate as managers. The women engineers have to engage in practices of renegotiation of identity despite having proven they are able to do the job. In order to achieve some sort of equilibrium, Gill et al. (2008) finds that many women undertake a range of tactics

whereby their femaleness is virtually denied or accentuated in order to create a persona that can ‘get by’ in the workplace.

2.3 Summary

- This chapter has explored a number of key areas in the existing literature pertinent to addressing the relationship between engineering cultures and women engineering students' gendered and professional identities. It has investigated:
  - *Cultures:* examining definitions of culture, organisational cultures, gendered cultures and the prevailing cultures in engineering industry and academia.
  - *Gendered identities:* addressing how gender is performed, managed and lived by individuals in everyday life and, particularly how this is experienced by women in a male-dominated environment such as engineering.
- The main findings of the literature review are:
  - Culture refers to the 'collective subjectivity' and manifests itself in everyday activities and dynamic beliefs and values.
  - Organisational cultures are highly gendered because perceived qualities needed to do the work or activities of the organisation are usually associated with one gender.
  - Engineering workplaces and academia are masculine gendered. Women working in these fields are overtly sexualised and subject to gender stereotypes.
  - Women and men 'do' and perform gender in social interactions. This impacts on how women behave when negotiating masculine organisational cultures, such as engineering.
  - Young women in particular face multiple contradictions about gender (in)equalities, which may also affect how they experience gender in a masculine environment. This has been shown to be especially relevant for young women in engineering.
- The extant literature therefore raises important questions about whether the gendered cultures of engineering and academic workplaces have penetrated engineering HE and, if so, what impact these cultures have on women engineering students' gendered and professional identities.
- The next chapter is focused on exploring existing literature on the key themes of the research: career choice and the culture of engineering in HE.

3. Entering the Engineering Profession

This chapter reviews existing research on some of the key themes of the research, particularly literature on career choice and engineering in the HE system. Specifically the chapter considers why women choose to study engineering, how their career decisions compare to men's, whether and how HE acts as a gatekeeper to the engineering professions, the prevailing cultures and structures of HE engineering and how these impacts on the curriculum and in turn both on women's interest and acceptance in engineering.

3.1 Career choices

Before exploring the specific reasons women choose to study engineering, it is important to put the research in context by briefly examining the concept of career before addressing in detail career theories that define processes of career choice and factors influencing career decision-making.

Arnold and Cohen (2008) state that there are competing conceptions of career, which have called into question the nature of successful careers. '*Traditionally the term career has been reserved for those who expect to enjoy rises laid out within a respectable profession*' (Goffman, 1961: 127). More recently, Arthur and Rousseau (1996: 6) define career as *'the unfolding sequence of a person's work experience over time*'. Arnold and Cohen suggest this definition avoids assumptions about the setting or form a career takes. It is also a useful definition in the context of this research, where the notion of career choice is employed. Here career choice and degree-level education can be seen as one of the first stages in this 'unfolding sequence' of 'career events'. Furthermore, there is no assumption that 'career' is objectively observable in terms of movement through organisational or occupational hierarchies (Arnold and Cohen, 2008). Similar to Evetts (1996), for example, the focus is on the 'subjective career', emphasising how individuals experience career with no prior assumptions of promotion and progress, but rather on how individuals perceive constraints, opportunities, problems and possibilities. In the context of this research then, career choice, or occupational choice is primarily focused on exploring the reasons students choose to study engineering, how students perceive they would like their careers to unfold and how, and where, they would like to work following graduation.

3.1.1 Career decision-making

Gati (1986) presents a career decision-making model based on the sequential elimination of alternatives. According to this model a student makes a career choice starting with a set of alternatives. They select aspects according to relative importance. Aspects that come into play are personal attributes (do I enjoy working with people?) occupational aspects (nature of the job), resources they have (money, time) and more information gathered around the field. The student then ranks the aspect by order of importance and eliminates occupations that fall outside the acceptable range, eventually leaving the most desirable option. Carson and Mowsesian (1990) critique Gati's model arguing that it presents a deterministic view of career decision-making that is focused too strongly on the outcome (i.e. the decision), and ignores the complex and dynamic nature of the decision-making process.

Dick & Rallis's (1991) career model states that students make their career choice on the basis of the relative values of the careers and their beliefs about themselves. The relative value of a career relates to both intrinsic factors such as intellectual interest as well as extrinsic factors such as expected salary and length of study. According to the model, student beliefs about themselves are formed from their interpretation of past experiences and perception of the attitudes and expectations of others, such as teachers and parents (referred to as socialisers). Dick & Rallis posit a dynamic relationship between the student and socialisers in which interactions shape their experiences and aptitudes. All of this takes place within the context of a particular set of societal stereotypes and realities, such as the sexual division in the workplace.

Woolnough's (1994) research yielded six categories of reasons for career choice:

- Extracurricular activities
- The way science is taught in class
- Career aspirations (includes salary and status)
- External factors of family background, hobbies, exposure to sophisticated technology
- Difficulty of the subject
- Ease of entry to course and possibility of sponsorship.

Johnson and Stewart (1997) point out that this list excludes reasons such as the influence of parents, the usefulness of the work, or the uniqueness of the student's particular study, factors which they found to be significant in research using an adaptation of Woolnough's questionnaire.

Shell et al. (1983), as part of the National Engineering Career Development Survey in the USA, grouped their list of factors into the following categories:

- Work characteristics (including salary, status, interest and contribution to society)
- (Prior) educational experiences
- People
- Technical experiences (e.g. hobbies)

These categories cover the same areas as the major elements of Dick and Rallis's career model, with the exception of self-concept.

Building on the theories outlined above and their own research, Jawitz and Case (1998) identify six categories of reason for choosing engineering as a career:

- Career rewards (REW), including job prospects, salaries and bursaries;
- Contact with engineering career (CAR), including career events and exposure to engineers and the workplace;
- Socialisers (SOC), including the influence of teachers and the presence of an engineer in the family;
- School subjects (SCH), including enjoyment or ability in maths, science or technical subjects;
- Social Identity (SID), including statements about making a contribution to the community or country, working as a team, wanting to be different or to prove oneself; and
- Engineering activities, which was subdivided into three further categories
    - Manual activities (MAN), including an attraction to practical activities, such as designing and building things, and working with real life situations;
    - Mental activities (MEN), including enjoyment of problem-solving, research and a curiosity about how things work; and
    - Challenge and variety (CHA), including the desire for a variety in one's work and the attraction to challenge.

Interestingly, careers advice does not feature in any of these models. This is confirmed by Evetts (1996) who found that careers advice at school had very little impact on students' decisions. In addition to these influences, Metz (2007) adds that students are prepared to study engineering because they understand that *'engineering education is synonymous with being a well-educated person … regardless of their ultimate career path'* (2007: 204).

This suggests that students who study engineering have not necessarily decided to pursue a career in the engineering fields. Similarly, Orndorff and Herr (1996) suggest that students are motivated by the promise of a fulfilling career and 'employability' may play a role in students' career decision-making. In a related argument, Evetts (1996) indicates that long-term career goals seem to have little influence on students' subject choice at university. Rather, as indicated above, students are motivated by interests and 'A' level subjects. This may go someway to explain McIlwee and Robinson's (1992) finding that many engineering students' said that they had no idea what the job role of an engineer involved before they entered the profession.

Lent et al. (2000) also explore factors that influenced students' career goals and the strategies used to cope with any difficulties implementing such goals. Their research focused on two groups of students, one from a university, and the other from a technical college. They found that few university interviewees selected alternative careers because they felt sufficiently deterred from pursuing their ideal choices. However, they did encounter barriers in implementing their career choices. Financial concerns were the most frequently cited choice impediment. Personal difficulties (e.g. problems adjusting to college, depression, time management problems), ability considerations (e.g. problems with academic progress or perceived ability), and negative social/family influences were mentioned as barriers to choices with moderate frequency. However, technical college participants cited personal difficulties with high frequency, financial concerns, and ability considerations and role conflicts with moderate frequency. Two barriers were unique to the technical college students: life events (including negative life experiences, such as the death of a parent, having to take care of one's siblings) and lack of familiarity/exposure (e.g. a perceived lack of exposure to skill-learning opportunities relevant to one's career goal).

University interviewees mentioned social support or encouragement (e.g. from friends, from family members) as a critical support factor in their choices. Moderate frequency categories included personal strengths (e.g. perceived ability, perseverance), direct experience with career-relevant tasks, role models/mentors, and expected outcomes (i.e. beliefs about job opportunities or rewards). The technical college sample, on the other hand, cited the college environment (e.g. encouragement from staff members, curriculum structure, job placement assistance), cognitive restructuring/reframing (e.g. efforts to keep a positive attitude or take a future-oriented perspective) and self-care (e.g. stress-reducing or anger-relieving activities). Interviewees reported coping in a variety of ways with the barriers they had encountered in implementing their choices. The university participants

reported using problem-focused methods (i.e. direct efforts at problem resolution such as increasing effort or taking fewer credits), social support seeking, financial strategies (e.g. taking loans, saving money), and cognitive restructuring/reframing moderately often as coping options. The technical college students mentioned social support and problem-focused methods with high frequency as barrier-coping strategies. Financial and cognitive restructuring/reframing strategies were mentioned moderately often. A few participants mentioned engaging in emotion-focused coping strategies (e.g. emotional catharsis, enjoying relaxing activities), which were designed to release tension or deal with one's own emotions rather than to confront a choice barrier more directly. This category was unique to technical college students.

Lent et al. (2000) also state that these findings should be interpreted cautiously given the size and composition (e.g. cultural, educational and economic features) of each of their samples. Because support and barrier perceptions are likely to be affected by socio-economic status, education level, cultures, and other life context factors, it seems important to extend this research to groups of career decision makers who are diverse with respect to race, ethnicity, social class, sexual orientation, age, and disability status and gender. Nevertheless, this study highlights the need to take into account the characteristics and environments of particular groups of decision makers when conceptualising career decisions. Madhill et al. (2007), for example, indicate that while individuals will be influenced by interests shaped by similar values, opportunities and personal and situational determinants, they are likely to deal with these in different ways. Gender differences in the interests and values motivating engineering students are thus explored further below.

While the focus here has been on exploring models of career decision-making, it is important to recognise that these are not without criticism. Patton and McMahon's (1999) systems theory of career development, for example, emphasises the profound influence of chance on career planning, stating that, *'given the complexity of influences in relation to career development, it is unreasonable to assume that the individual's career development is planned, predictable or logical'* (1999: 166).

3.1.2 The role of gender on career choice

Much research on careers has focused on white, middle-class males. Since the 1980s, there have been some attempts to redress the balance (see Arnold et al., 1991). Arnold et al. (1991) maintain there is no doubt that women are at a disadvantage relative to men in the labour market. This section therefore examines the extent to which existing theory

and practice reflect women's needs and career problems, as well as questioning when career choice begins. While much examination of why individuals choose careers have focused on later stages when individuals actually choose to enter jobs, less attention has been paid to the activities at early stages on the paths leading to specific careers (Correll, 2001).

3.1.2.1 Socialisation

The engineering sector does not operate in isolation from wider society where stereotypical assumptions, societal influences on choice of career and prejudicial attitudes and behaviour still operate to the detriment of those who are in a minority or disadvantaged position (Dainty et al., 2004). While this may sound extreme, it is true that gender differences emerging in early childhood are relevant to careers, particularly as such differences can narrow the options available to individuals making career decisions. Some career models have addressed this. For example, O'Neil et al.'s (1980) career model explicitly analyses the factors affecting sex role socialisation, as well as career decision making.

McIlwee and Robinson (1992) maintain that children learn at an early age which occupations are 'women's work' and 'men's work', and shape their aspirations accordingly. Keller (1983) and Henwood (1998) argue that processes within schools present SET as more 'natural' to men than women. Siann and Callaghan (2001) suggest these processes operate on an explicit level, whereby teachers pay more attention to male students in science classes, and at an implicit level, where discourse associates masculinity with technology. Opportunity 2000 (1996) maintain that this suggests there is a psychological barrier to overcome if more girls are to be attracted to science subjects. These attitudes have a powerful impact on children's views of their own strengths and weaknesses (Opportunity 2000, 1996). Correll (2001) supports this, arguing that widely shared cultural beliefs about gender and task competence bias individuals' perceptions of their competence at various skills. Cox and Cooper (1988) state that childhood events act as constraints on the potential for influences to cause change in an individual in later life. For example, even though girls perform just as well as boys up to GCSE, they reject science subjects when they reach 16. Walkerdine (1988) argues that socialisation theory, constructs women and girls as passive objects rather than active subjects in relation to social norms and expectations. Phipps (2007) suggests that constructions of female passivity seem to undermine other arguments which maintain that women are as capable as men in SET. However, these processes have not prevented women from pursuing biological and medical sciences (Crompton and Sanderson, 1990). Nevertheless, higher

numbers of women have not guaranteed their advancement and promotion (Ellis, 2003; Fielding and Glover, 1999). Women in these 'feminised' areas of science tend to hold positions with lower status and visibility, fewer opportunities and lower pay than their male colleagues, showing that 'getting in' is not necessarily the same as 'getting on' (Fielding and Glover, 1999).

3.1.2.2 Gender and career choice

Whittock (2002) insists that career decisions remain strongly influenced by gender. Career plans of young women have been found to be consolidated by the stereotypical nature of work experience undertaken by the majority and by lack of access to appropriate role models. Arnold et al. (1991) review several theories concerning aspects of women's career development. This included Fassinger's (1985) model of college women's career choice, Betz and Hackett's (1981) examination of how self-efficacy influences women's career choices and aspirations, and Gattiker and Larwood's (1988) analysis of what career success means for women. These and other studies recognise that the socialisation of girls and societal expectations of women's and men's roles are likely to have profound effects on the way women think about their careers. The same is true for men, but this is less often recognised because of the temptation to take male socialisation and values as an unquestioned norm.

A number of studies report that women and men have different profiles of reasons for choosing engineering. These found that:

- Pay was a more important factor in career choice for men than women (Dick & Rallis, 1991);
- Women were more influenced by involvement with human issues (Woolnough, 1994; Shell et al., 1983; Lewis et al., 1999) and appeared to have a strong social ethic (Gill et al., 2008);
- Men were more influenced by their experience of engineering-related activities, while women seemed more attracted by the characteristics associated with the career itself (Shell et al., 1983);
- Men cited scientific hobbies and 'fiddling with gadgets' more often than did women (Woolnough, 1994);
- Women were influenced by a wider variety of factors than men (Shell et al., 1983);
- Men were encouraged more by their fathers than women (Rosati & Becker, 1996), although others have argued that women often have a family connection with engineering (Gill et al., 2008);

- Women were more likely than men to credit a teacher with encouraging them to study engineering (Evetts, 1996; Gill et al., 2008);
- More women than men cited 'wanting to be different' (Kent & Stublen, 1995); and,
- Ability in mathematics and science was cited more by women than by men (Kent & Stublen, 1995; Gill et al., 2008).

Evetts (1998) and Gill et al. (2008) found that women were attracted to engineering by the everyday practices of work, for example, 'solving problems' and 'working problems through', 'identifying problems' and 'working to solve' them. The procedures and practices of doing engineering and the team discussions about applications, processes and practicalities were what made the work appealing. The 'hands-on' experience and the production of 'results' are what made the work attractive. These relate closely to Jawitz and Case's (1998) engineering activities category (MAN, MEN and CHA).

Jawitz and Case (1998) found in their research in South Africa, that the reasons students give for studying engineering are independently and significantly associated with the variables of race, gender and discipline. With reference to the categories of choice, identified earlier, they found no significant difference by gender or race between career rewards (REW) and contact with engineering career (CAR). The categories socialisers (SOC) and school subjects (SCH) showed similar differences in response. Both these categories of reason were mentioned significantly more by white students than by black students, and, amongst white students, by women students than by male students. Manual activities (MAN) were mentioned significantly more by white students than by black students and more by men students than by women students. Mental activities (MEN) were mentioned significantly more by white students than by black students. Challenge (CHA) was mentioned significantly more by women students than by men students. Within the category social identity (SID), wanting to be different or to prove oneself was particularly in relation to being a member of an underrepresented group in the engineering profession. These reasons were mentioned significantly more by black students than by white students and, women students also mentioned this category more than men students. The attraction to challenge and variety of engineering (CHA) was the only category of reasons that revealed a significant gender difference but no difference by race. However, the women in the sample chose a non-traditional career and, according to Jawitz and Case (1998), therefore may be less likely to be deterred by a challenge.

The findings of Jawitz and Case (1998) have implications for initiatives aimed at attracting more women and minority students into engineering studies. Not only do the social

dimensions of an engineering career need to be emphasised in the publicity aimed at students, but curricula and workplace experiences need to build on and sustain the differing initial motivations in order to retain these students in the profession.

Additional gender differences relate to career choice and perceived employability. McIlwee and Robinson (1992), for example, found that men believed women's employability would be improved in engineering simply because they were women. Similarly, McLean et al. (1997) also found men students believed women would receive preferential treatment from employers, who they perceived would want to employ women to improve their equality and diversity profile. In other words, there was a perception among men that women in engineering might be employed because of their gender, rather than their status as 'good engineers'.

3.1.3 Choosing a career in engineering

Interestingly, Jawitz et al. (2000) interviewed non-engineering students to explore engineering as a potential career option in their career decision-making process. They found only two science students had engaged with engineering as a potential career. These two students had attended what they call 'strong science schools' and had a positive attitude to science. Jawitz et al. (2000) find that decisions not to study engineering are based on quite careful and strategic choices. It seems that the experience of science in schools is a significant factor influencing the choice of engineering and that prospective students of engineering are likely to be found amongst those young women considering registering for a science degree. Jawitz et al. (2000) note, however, the phenomenon of top women maths and science students being directed towards medicine by a range of socialisers. They consider that this profession has become 'gender neutral' in recent years, and that it might be useful to uncover how and why this happened, to see if there are any lessons for the engineering profession. However, while numbers of women in medicine and law, for example, have substantially increased, the professional hierarchies in these professions '*continue as entrenched bastions of male power'* (Gill et al., 2008: 225; see also Fielding and Glover, 1999). Webster & Burrowes (1998) made a preliminary analysis in this regard, and suggest that women's experience as consumers of medicine has influenced the ease with which they have recently entered the profession.

Rodgers (1991) addresses why women choose a career in construction, and what their career expectations are. Rodgers evaluates the perceptions of the construction industry held by 'A' level students, women and civil engineering undergraduates, and graduates.

She found that both men and women 'A' level students lacked the specific knowledge required to consider a degree in engineering. Rodgers suggests that professionals should be encouraged to pass on their knowledge and experience of the industry to the younger generations, in particular women, so women students may have role models in the profession.

According to Evetts (1998) the importance of management positions for career progression in engineering continues despite a proliferation of technical specialist, professional engineering positions and a reduction (down-sizing) in managerial positions in industrial organisations. For example, at the company in Evetts' study, it was widely accepted that only managerial posts in engineering could lead to the highest positions in the organisation, the company senior staff. The culture of 'good' management and the demonstration of management potential was incompatible with women's responsibilities in the private sphere and with styles of management that might emphasise caring, relatedness and connectedness. Consequently women who were seeking promotion in their engineering careers either elected for the professional route or had to demonstrate promotion potential in traditional ways, that is through appropriate indications of commitment such as working long hours and demonstrating individualistic and competitive attitudes, and toughness in the management of men. The women had to do the adapting and work within existing cultures. Analysis of career literature, suggests, however, that this is not only a problem of engineering; organisations generally need to adopt or accept alternative definitions of career, in order to be inclusive to minority groups such as women. However, the problem may be heightened in engineering because of the industry's tendency to reject change, as we have seen in its resistance to women.

Engineering as a profession has had to face particular problems in respect of career development. The Finniston report (1980) recognises that the career movements of engineers into management posts weakened the sense of professional identity for engineers. For women engineers, however, the expectation of career progress into management poses additional career dilemmas. It is necessary for the engineering sector to challenge the 'bureaucratic career' where promotion and career development involve moving into management, and to accept more fluid, or less hierarchical, notions of career, where women may have more opportunities. This argument does, however, need to be approached with caution, as it is not intended to suggest that women are not suited to, or capable of, management roles.

3.2 Engineering in higher education

The following section builds on the engineering and academic cultures described in chapter two, to investigate the cultures of engineering in HE and how these impact on women students. Having decided to study engineering at university, women's experiences in engineering HE are likely to have a significant impact on whether they continue to pursue a career in the engineering profession.

3.2.1 HE as gatekeeper to engineering

Whatever the culture in academia and HE, it has been argued that engineering education needs to change and move forward in order to smooth the transition between education and paid employment and to ensure that graduates fulfil the requirements of industry. Gill et al. (2008), for example, argue that the road from success in school and university through to full recognition as a professional in the workplace is far from a smooth unproblematic trajectory, particularly for women in male-dominated disciplines.

Although employers are keen to recruit graduates, and value the intellectual and technical skills they possess, they are somewhat critical of UK HE institutions for not sufficiently developing a wider range of skills, especially social skills, relevant to employment (National Advisory Body, 1986). Graduates themselves tend to agree (Brennan and McGeevor, 1998). Nicholson and Arnold (1989) question whether it matters if universities fail to prepare their students for employment and whether they could do otherwise. Such deficiencies matter to the extent that employers expect and are disappointed in the skills, knowledge and experiences that their graduate entrants bring with them. Yet, although these shortcomings can be viewed critically as a kind of training obsolescence, they are not irrecoverable, as interviewees mostly affirmed the benefit of acquiring these skills after entry. It follows then, that what matters is the kind of misapprehensions graduates and recruiters are under when they consider the transition from HE to employment. Graduates are ill prepared for how different life will be, while recruitment interviewers are, illogically, selecting on qualities that can be readily developed during the early employment period.

Nicholson and Arnold (1989) interviewed graduates who had experienced sandwich degree courses and could testify to their benefits. However, this may illustrate that many of the necessary workplace skills cannot be taught so readily in the classroom as they can be learned through direct experience. Role-playing aspects of business and its interpersonal demands may have a useful function in some courses, but it cannot constitute any more than a diluted and short-lived simulation, supplying partial, though

valuable, anticipatory socialisation. A manager responsible for the training of graduate engineers similarly told Nicholson and Arnold that most of his charges had to unlearn a good deal of their university engineering before they could get to grips with the kinds of problems the company's projects presented. Although universities could do a better job of forewarning students about the changes to come, employers are likely to differ in what they want from graduates. Whilst HE institutions could be doing a better job of orienting graduates towards employment, it is still arguable that they can only attempt the modest beginnings of a learning process that only really takes off after 'real work' has commenced.

Martin et al. (2000) maintain that the academy and the workplace hold different priorities, goals and values, and thus it is difficult for the university to align itself fully with the workplace's needs. They reflect that while study at university is recognised as a laudable goal in itself, it is increasingly being seen as a primary means by which students are prepared for later employment. In general, university learning tends to be individualistic and focused on individual competition, whilst work is often conducted in a social, cooperative context involving collaboration as a team worker; universities tend to foster broader learning while work is often task-specific; universities often impart and inculcate decontextualised knowledge while work relates more to contextualised knowledge; and the sheer diversity of vocational aspirations makes it difficult for universities to prepare every student for every possible career path.

Traditionally there have been two main views about the purpose of education: a functional or vocational view that education should prepare its recipients for their positions in the occupational structure of society, and a liberal view that education is valuable for its own sake and for the fulfilment of the individual (Auburn et al., 1993). These two sets of values do not necessarily lead to compatible outcomes. The emphasis upon one or other of these sets of values has led some to distinguish a distinctive role for the placement in sandwich courses in different disciplines. One consequence is that the placement can become a site of competition between these differing value systems, leading to a mismatch in expectations about the nature and outcomes of the placement for the different parties to it. The workplace supervisor may view the placement student as someone to be trained and 'moulded' to the requirements of his or her particular industry. The academic tutor may put a high priority upon the student's ability to develop insights about the subject and to clarify vocational goals. In turn, the student may experience competing expectations of his or her role. Nevertheless, Auburn et al. (1993) argue it is clear that HE, the Engineering Council and industry should attempt to reach a

compromise about the content, and methods of teaching, on engineering courses in the UK.

3.2.2 HE engineering cultures

McLean et al. (1997) indicate that engineering education is dominated by a masculine culture characterised by a particular set of beliefs, behaviours and assumptions. Mills and Ayre (2003) suggest that there have been a number of findings that many women experience a 'chilly climate' in SET courses, and it is likely that other minority groups share similar experiences. Unhappy or uncomfortable students will not achieve as well as they might in a more supportive environment, and they may even leave the course. Some of the features of the 'chilly climate' that Mills and Ayre (2003) identify include:

- Erroneous assumptions by lecturers that all students have prior 'tinkering' experience (practical familiarity with mechanical and electrical devices and appliances) (Lewis, 1995)
- Lack of excitement in the content or presentation of the course (Nair and Majetich, 1995)
- Apparent lack of relevance in the curriculum content (Lewis, 1995; Lintern, 1995)
- Teaching methods that are appropriate for only a very limited range of learning styles (Lewis, 1995; Jolly, 1996)
- Disruptive behaviour of majority groups (e.g. white male students throwing paper planes) (Lintern 1995; Jolly 1996), and
- Classroom atmosphere uncomfortable for some students because of racism, sexism, or similar attitudes (Lewis, 1995; Lintern 1995; Jolly 1996; McLean et al., 1997);
- Special treatment, such as additional help from male lecturers, which may lead to resentment from male peers (McLean et al., 1997).

On the other hand, McIlwee and Robinson (1992) also found some positive elements in the engineering HE culture, such as the camaraderie and cooperative spirit among students, including women, whereby students learnt that by cooperating they could all gain better grades. McIlwee and Robinson also argue that engineering HE cultures value academic work at which women excel, whereas engineering workplace cultures value such masculine strengths as *'a fascination with technology, expertise as a tinkerer, and an aggressive style of self-presentation'* (1992: 50). They argue that knowing how to conform to masculine engineering cultures and doing it well are critical to women's success in the workplace. However, they only consider that this becomes an issue when women make

the transition from education to work. They believe that in the workplace women engineers not only have to show competency in their knowledge and skills but also have to learn to perform and enact masculine norms of attitude and interaction. While, this is not disputed, McIlwee and Robinson fail to recognise that the very knowledge and skills women learn in engineering education, or at least the ways in which these skills are taught and learnt, encompass masculine norms and attitudes.

The US National Council for Research on Women report (Thorn, 2000) shows the importance of the first year for women having entered engineering in HE. Since women tend to evolve an interest in technology over time, the typical first year 'killer' exams designed to weed out students rather than invite their participation may be counter productive for retaining women students. Similarly, McIlwee and Robinson (1992) found that engineering students complained about the difficulty of their programmes. Although McLean et al. (1997) suggest that for male students, the high workload reinforced the high status of engineering degrees, particularly in comparison to arts programmes, which are usually dominated by women. Copeland (1995: 18), however, indicates that '*recognising the different skills, perspectives and learning styles that women bring to engineering and incorporating these into the teaching and learning environment'* means challenging the assumptions and practices within engineering itself.

As discussed earlier, part of the problem may be that once the decision to study engineering has been made, commitment to the field does not automatically follow. Etzkowitz et al. (2000: 133) show that educational experiences have a cascade effect on commitment: '*A cascade of affirming experiences serve to amplify a string of positive effects, until there is a short-circuit and the process is reversed … what had the potential for a cumulative positive cascade of experience becomes short-circuited by negative experiences'.*

Lewis (1995) found engineering teaching to be strongly male biased: *'The research questions, methods, criteria of success, and styles of teaching are male defined, and consequently, the knowledge itself reflects a bias towards a male cognitive style in its practices, theories, and ways of teaching'*. This is a worrying trend given that Mills and Ayre (2003) emphasise the desirability of structuring an engineering curriculum around a general recognition that students from diverse backgrounds bring different perspectives, attitudes and values to the engineering classroom, without making distinctions between the specific cultural groups represented in the class. This is supported by Sagebiel (2003), who suggests that an improved curriculum would make both the climate and content of teaching appropriate to attract and retain both men and women. Improved

teaching is particularly relevant to women, as the WEPAN (Women in Engineering: Programmes and Advocates Network) policy climate survey, exploring the environment for undergraduate engineering students, found that men are less affected by poor teaching, poor organisation of course material and by dull course content (see Sagebiel, 2003).

In addition to direct sexism and the numerical domination of men studying, teaching and practising SET, gender stereotypes have been reinforced by taking mens' experiences as the norm while marginalizing those of women (Srivastava, 1996). Kelly (1985) explains that this has occurred through the representation of gender in textbooks, the male orientated curriculum (such as in examples and applications used) and classroom interaction. In the presentation of SET education, women scientists have been invisible (in terms of numbers and examples given). SET is presented out of context, without reference to local or social issues and implications. Moxham and Roberts (1995) describe this as a gender-exclusive curriculum, with bias in language, assumptions, curriculum design, classroom interactions, and teaching and assessment methods. This problem is significant as girls are seen to be 'best' at contextualised, purposive, relational learning, appreciating complexities rather than reductionism (Jorg and Wubbles, 1987).

Thomas (1990) shows that disillusionment amongst students has arisen through excessive maths and quantitative content, narrowness and the abstraction of the curriculum, lack of relevance to the 'outside' world, too early specialisation and the need to conform to rigid rules, without the opportunity to challenge them. This has led to passive learning, acceptance of facts on trust and frustration. In terms of the learning context and curriculum, both Greed (1991) and Thomas (1990) describe the impersonal and indifferent atmosphere of SET departments. This is manifested, for example, in formal teaching methods and the interpretation of professionalism in masculine terms. As Byrne (1987) points out, teaching styles in SET can be instrumental and non-negotiable. As a result of these methods of teaching there is little debate, interaction or concern for the aesthetic. However, recent initiatives in the UK have started to promote good practice in teaching and learning, with the aim of providing the best possible learning experiences for students. Relevant initiatives include the Higher Education Academy National Teaching Fellowship Scheme, established in 2006; the Engineering Centre for Excellence in Teaching and Learning (engCETL), established in 2005; and, the Engineering Subject Centre, established in 2000, as part of the LTSN (Learning and Teaching Support Network), which became the Higher Education Academy in 2004.

Madhill et al. (2003) write that career decision-making is impacted on by a number of factors, of which hands-on experience is particularly influential. Without the opportunity

for hands-on learning, students report that they do not automatically appreciate the application of what they are studying to their personal aspirations and the things they care about. Many students in Srivastava's (1996) study also pointed to the lack of opportunity for practical work. They felt the emphasis on broad, theoretical, historical and textbook contexts was irrelevant, limited in usefulness and remote from industry.

3.2.3 Curriculum content

Mills and Ayre (2003) suggest that the typical engineering curriculum has been blamed for the difficulties in recruiting and retaining women engineering students. Beder (1989) describes it as showing an *'obsession with the technical, the mathematical, and the scientific, and an almost complete neglect of the social, political and environmental issues'* which discourages *'students with broader interests, a different range of talents …; those who want to work with people rather than machines and numbers, those who care about social relations. Too often it is the female students who are put off'* (Beder, 1989: 173). Thomas (1990) also suggests that HE curriculum is male-centred. She shows that subjects are not neutral but gendered in that they are socially and culturally constructed. Weiss et al. (1990) argue that teaching and assessment material familiar and relevant to women, including the ethical, human and social context of science and technology, should be incorporated into the curriculum. Hodgson (1993) illustrates the appeal of interdisciplinary courses, for example the use of social science, health, environmental and philosophical concepts, processes and problems in science and technology courses.

As indicated above, to some extent, this is already occurring, with increasing opportunities for student interaction, participation and activities in engineering subjects (Dickens and Arlett, 2009). Mills and Treagust (2003) found that innovative teaching methods were far from widespread and usually only implemented on individual courses within traditional engineering programmes, rather than integrated as a whole curriculum approach. New approaches to learning include project-based, problem-based and investigation-based learning. Some examples of these innovations can be found at Aalborg University in Denmark, where 75% of engineering programmes are project-related courses (Mills & Treagust, 2003), the University of Manchester's School of Engineering, which introduced problem-based learning as the primary teaching method for undergraduate engineering programmes in 2001 (Engineering Education Centre, 2003), and the School of Mechanical and Aerospace Engineering at Queen's University, Belfast, which has reformed existing

course to incorporate CDIO (Conceiving, Designing, Implementing, Operating[2]) and has developed a new course, Product Design and Development, shaped entirely by CDIO principles (McCartan et al., 2008). However, further research is required to address how new, innovative teaching practices impact on women and men, and whether there are gender differences in their experiences of these learning practices.

Srivastava's (1996) research, while focused on construction, is equally applicable to engineering. She shows that lecturers and some professional bodies define construction in technical terms and therefore emphasise core knowledge as maths, science and technology. She suggests that many women construction students found this focus difficult, irrelevant, disappointing and uninteresting. Despite some recognition of the need for a more balanced curriculum Srivastava found that change was limited because tutors, the majority of students and professional body representatives supported the primacy of the technical definition of construction problems. She recommends a need for radical change in HE to tackle this. She maintains that such changes may involve presenting construction disciplines in a social context; considering practical applications; integrating modules from social sciences and humanities; questioning assumptions, traditions and the culture of construction education and practice; relating topics to a range of student experiences; addressing the social and environmental impact and benefits of construction; incorporating interactive, qualitative, critical and ethical considerations in projects; and mentoring of students and staff who are in a minority. Language and examples used in construction course content are important conveyors of culture and values and should not be exclusionary, sexist, ethnocentric or homophobic. This is true even for innovative teaching methods, such as problem-based learning, where the content of problems can potentially reinforce gender biases by using stereotypes which implicitly state 'acceptable' behaviours for men and women (Phillips, 1997). Black and Atkins (1996), for example, indicate that examples and illustrations used in teaching will reflect the bias of those who choose them and will not necessarily appealing to a diverse range of students. Srivastava also suggests that feminist perceptions of science and technology should be incorporated into the construction curriculum, to facilitate questioning of assumptions, and challenge conservatism and traditionalism in the construction industry.

However arguments, such as those of Srivastava, have been criticised for their essentialist standpoint and reinforcement of gendered binaries which suggest that men are comfortable with abstract and mathematical thinking, while women prefer to engage

[2] For further information about CDIO visit http://www.cdio.org/ an international website, which explains CDIO and details participating universities worldwide.

with practical applications or the social and human aspects of engineering (Phipps, 2007; see also Hughes, 2001). In reality, of course, it may be that both men and women are uncomfortable with abstract notions and both genders may benefit from an overhaul of the engineering curriculum to incorporate a more practical approach.

Bagilhole and Goode's (1998) research found that in SET HE a narrow definition of the term curriculum was predominantly used, and was seen to refer to a well-defined body of knowledge which was to be transferred to students largely by lecturing. This is in line with Thomas's (1990) study, which showed science departments as characterised by a formality of pedagogy which involved the definitive authority of lecturers and the passivity and dependency of the students, the predominant use of the lecture, the abstract nature of the subject content, and the heavy amount of prescribed and controlled laboratory work. Bagilhole and Goode found that although concerns in science and engineering departments centred around access, in practice this referred to access to courses, in terms of recruitment of undergraduates, and did not encompass access to the curriculum itself, or considerations of how far there are differential curricula and therefore differential access to and engagement with particular aspects of the curriculum.

Bagilhole and Goode's study shows that awareness of issues in curriculum innovation was highest in the social sciences and humanities. However, departments with few women students or staff failed to recognise the issues. Bagilhole and Goode indicate that the main barrier to progress in these departments was the view that women's low participation was not attributable to the culture or curriculum, but the fact that women were simply not interested in the subjects on offer. Bagilhole and Goode also found that HE staff commonly perceived that women need to change to accommodate industry, not the other way around – women must learn to adjust to industry, cope with it and 'fit' into it. Women engineering undergraduates at the university in their study were apparently learning to be discriminated against. The role of the university was seen simply to prepare them for 'real life' and anything else was seen as unfair. Both the formal and informal curricula remain gender-blind in their operation – and in the name of equality are treating all students 'the same'. Bagilhole and Goode suggest the implications of their research for women are twofold. Firstly more women are attracted to the broader-based courses in other universities. And women who are attracted to this institution are likely to find the homogeneity of a predominantly male group, the teaching style and the compatibility between the two, difficult to question in the event of experiencing limitations on access to the curriculum as currently designed and delivered.

3.3 Summary

- This chapter has explored a number of key areas in the extant literature in order to develop an understanding of women engineering students' career choices and experiences of engineering HE cultures. It has investigated:
  - *Career choice:* looking at broad perspectives of career decision making and more specifically within engineering, as well as the impact of gender on career choice.
  - *Engineering in HE:* exploring how HE is a gatekeeper to the professions, how engineering and academic cultures are reproduced in engineering HE and, how this affects women engineering students.
- The main findings of the literature review are:
  - Career choice is influenced by a number of factors, including: family, friends and teachers, exposure to career, perceived rewards, interest and enjoyment of relevant subjects, ability and sex role socialisation.
  - Women and men's engineering career decisions may be based on differential factors.
  - Engineering HE is both a gatekeeper to the engineering professions and key to students' smooth transition between education and employment. While education and employment may have different priorities and values, graduates and employers have questioned how far HE really prepares students for the workplace.
  - In engineering the relevance of the curriculum has been called into question while, at the same time, both the curriculum and styles of teaching have been criticised for creating a 'chilly climate' for women, which may influence women's commitment to a career in engineering.
- These findings, along with information about women's under-representation and experiences in engineering set out in chapter one, *Introduction*, have started to explore how women engineering students' experiences of engineering HE impact on their career intentions.
- However, the extant literature has not addressed the specific relationship between HE engineering cultures and women engineering students' identities, nor the extent to which women in HE challenge or maintain existing engineering cultures.

- This research therefore intends to address these knowledge gaps by examining women's identities through their career choice decisions, the nature of engineering HE cultures and, the potential impact of these cultures on women students' gendered and professional identities.
- This is described further in chapter four, *Methodology,* which details the aims and objectives of the research, as well as the research methods and tools for data collection and analysis.

4. Methodology

This chapter establishes the aims and objectives of the thesis, before describing the philosophical background, the methodology employed and the methods used to implement the research. It addresses each phase of the research in turn and includes a discussion about the selection of each method, access and selection of research participants, the data collection tools and a summary of data collected. It also details the data analysis employed, acknowledges ethical dilemmas in the research and provides an evaluation of the research techniques.

4.1 Aims and objectives

As shown in the preceding chapters, there has been much research into how and why women have been deterred by both the engineering industry and academia, despite many initiatives over the past twenty years to counter this. However, gender research in academia has tended to look at staff rather than students and research concerning women in engineering has focused either on recruiting or promoting the industry to women of school age, or retaining women once they are employed in the engineering sector. Other HE-related literature has tended to focus on the problem of recruitment, rather than course content or approach. Two key questions emerge from the extant literature:

- What is the relationship between engineering cultures and women engineering students' gendered and professional identities?
- Do women engineering students challenge or maintain existing engineering cultures? How and why do they do this?

Given these questions, the research aims to examine the impact engineering cultures have on women engineering students' gendered and professional identities. It is simultaneously focused on exploring how gendered and professional identities are shaped by women's experiences of engineering cultures and how women's experiences are shaped by their gendered and professional identities. It will also analyse the relationship between women engineering students' gendered and professional identities.

The specific objectives are to:

- Examine women engineering students' career choices and whether career decisions are gendered;
- Investigate women engineering students' experiences of HE engineering cultures;
- Explore the relationship between engineering education cultures and women engineering students' gender and professional identities;
- Assess whether women's attitudes, experiences and environment vary according to their engineering discipline;
- Address what implications the findings may have for strategies and policies to attract and retain more women in engineering education and engineering careers.

The investigation of gender and identity is implicit throughout the research, which seeks to reveal how gender and identity are presented and represented, performed, contested and transformed (Järviluoma, 2003: 24). This is achieved by addressing women's career choice decisions and experiences of HE engineering cultures.

4.2 Philosophical background

Walliman (2006) indicates that the formulation of research questions and the way research is carried out is based on the epistemological and ontological viewpoint of the researcher. However, he also stated that given the diverse range of theoretical perspectives, it is probably inappropriate to find a single model of social and cultural life. Epistemology is concerned with how we know things and acquire knowledge. There are two main, and opposing, approaches:

- *Positivism:* the application of the natural sciences to the study of social reality. An objective approach that can test theories and establish scientific laws. It aims to establish cause and effect.

- *Interpretivism:* the recognition that subjective meanings play a crucial role in social actions. It aims to reveal interpretations and meaning.

Ontology is concerned with what exists to be investigated and again there are two main and opposing perspectives:

- *Objectivism:* the belief that social phenomena and their meanings have an existence that is not dependent on social actors. They are facts that have an independent existence.

- *Constructivism:* the belief that social phenomena are in a constant state of change because they are totally reliant on social interactions as they take place. Even the account of researchers is subject to these interactions, therefore social knowledge can only be indeterminate.

Figure 4.1 Comparison between positivist and interpretivist approaches.

Dimensions of Comparison	Positivist	Interpretivist
Philosophical basis	Realism: the world exists and is knowable as it really is. Organisations are real entities with a life of their own.	Idealism: the world exists but different people construe it in very different ways. Organisations are invented social reality.
The role of social science	Discovering the universal laws of society and human conduct within it.	Discovering how different people interpret the world in which they live.
Basic units of social reality	The collectivity: society or organisations.	Individuals acting singularly or together.
Methods of understanding	Identifying conditions or relationships which permit the collectivity to exist. Conceiving what these conditions and relationships are.	Interpretation of the subjective meanings which individuals place upon their action. Discovering the subjective rules for such action.
Theory	A rational edifice built by scientists to explain human behaviour.	Sets of meaning which people use to make sense of their world and human behaviour within it.
Research	Experimental or quasi-experimental validation of theory.	The search for meaningful relationships and the discovery of their consequences for action.
Methodology	Abstraction of reality, especially through mathematical models and quantitative analysis.	The representation of reality for purposes of comparison. Analysis of language and meaning.
Society	Ordered. Governed by a uniform set of values and made possible only by these values.	Conflicted. Governed by the values of people with access to power.
Organisations	Goal-oriented. Independent of people. Instruments of order in society serving both the society	Dependent upon people and their goals. Instruments of power which some people control and

Dimensions of Comparison	Positivist	Interpretivist
	and individual.	can use to attain ends which seem good to them.
Organisational pathologies	Organisations get out of kilter with social values and individual needs.	Given diverse human ends there is always conflict among people acting to pursue them.
Prescriptions for change	Change the structure of the organisation to meet social values and individual needs.	Find out what values are embodied in organisational action and whose they are. Change the people or change their values if you can.

Source: Cohen and Manion (1994: 10-11).

On the whole, this study is informed by an interpretivist epistemology and constructivist ontology, which aims to reveal how women engineering students construct, interpret and understand their experiences.

4.3 Methodological approach

4.3.1 Qualitative research

The qualitative approach is used according to Mason's (1996: 4) working definition of qualitative research as:

- Grounded in a philosophical position that is broadly 'interpretivist' in the sense that it is concerned with how the social world is interpreted, understood, experienced or produced;

- Based on methods of data generation that are flexible and sensitive to the social context in which the data are produced, rather than rigidly structured, or removed from real life.

- Based on methods of analysis and explanation building that involve understandings of complexity, detail and context. Qualitative research aims to produce rounded understandings on the basis of rich, contextual and detailed data. There is more emphasis on holistic forms of analysis and explanation than on charting surface patterns, trends and correlations.

Qualitative research seeks to answer questions by examining social settings and the individuals who inhabit those settings. According to Berg (2007), qualitative researchers are most interested in how people arrange themselves and their settings and how people make sense of their surroundings through symbols, rituals, social structures, social roles, and so on. Qualitative research provides a means of accessing unquantifiable facts about the people researchers are investigating. As a result, Berg (2007) states that qualitative methods allow researchers to share in the understandings and perceptions of others and to explore how people structure and give meaning to their lives, and how they make sense of themselves and others.

Langdridge (2004) suggests that the key advantages of qualitative research are that it recognises the subjective experience of participants; it may produce unexpected insights about human nature through an open-ended approach to research; it enables an 'insider' perspective on different social worlds; it does not impose a particular way of 'seeing' on the participants. However, some disadvantages are that it generally does not apply traditional notions of validity and reliability; and, it is often not appropriate or even possible to make generalisations or predictions.

A qualitative approach is therefore particularly suited to this research which is focused on exploring subjective experiences, including women engineering students' experiences of HE engineering cultures and the impact of these cultures on their identities.

4.3.2 Quantitative research

Quantitative research concerns the quantity or measurement of some phenomenon (Langdridge, 2004). Quantitative research is often conducted in controlled settings, such as laboratories, in order to produce findings that are as objective and unaffected by external influences as possible. Quantitative research also tends to focus more on behaviour than qualitative research, which is more focused on meanings. Quantitative research has often been focused on prediction rather than only description. Finally, quantitative research tends to involve either the use of experimental methods or the use of structured questionnaires, often conducted with large numbers of participants. Langdridge (2004) suggests that some of the advantages of quantitative research are that it is precise (in terms of measurement); controlled (in terms of design); makes claims about causation; has predictive power (can generalise to other settings on the basis of findings in a particular setting). Disadvantages are that it can grossly oversimplify the complexity of human nature; it fails to recognise the subjective nature of all social science

research; and it does not recognise the individuality and autonomous nature of human beings (Langdridge, 2004).

4.3.3 Combining qualitative and quantitative research

Bryman (2006) suggests that quantitative and qualitative research are increasingly seen as compatible because they offer the researcher the best of both worlds. Furthermore, multiple methods can reveal slightly different facets of the same symbolic reality (Berg, 2007).

Greene et al. (1989) maintain that there are five justifications for mixing methods:

- *Triangulation*: to seek corroboration of results from different methods studying the same phenomenon;
- *Complementarity*: to seek elaboration, enhancement and clarification of results;
- *Development*: to use the findings from one method to help inform the other method;
- *Initiation*: to discover paradoxes that lead to reframing the research question(s);
- *Expansion*: to extend the breadth and range of the research using different methods to investigate different aspects of the research.

Hammersley (1996) also adds *facilitation* to this list, meaning that one research method is employed in order to aid research using another strategy. Morse (2003) suggests that by combining and increasing the number of research strategies used the scope of the research can be extended and it is possible to build a more complete picture of the phenomenon under investigation.

4.4 Adopting a multi-method design

Following Morse's (2003) definition, this research adopts a multimethod design, with an inductive theoretical drive. The specific design of the research is dominated or driven by an inductive qualitative method supplemented by the sequential use of a quantitative method and a second qualitative method, in order to explore the impact of HE engineering cultures on women students' gendered and professional identities.

It is intended that the qualitatively driven approach will allow the investigation of women students' experiences of engineering education, rather than providing a descriptive, taxonomical account of all women engineering students. The research is, therefore, more concerned with *understanding* and *exploring*, rather than measuring the relationship

between women students and engineering education. It is hoped that a qualitative approach will allow the interpretation of meaningful relations, rather than quantifying objective data.

The multi-method approach, as stated above, combines interviews, focus groups, and a questionnaire. This approach employs *complementarity*, in that different methods are used to elaborate and enhance the findings of the other methods and, *expansion,* to investigate different aspects of the same phenomenon (Greene et al., 1989; Hammersley, 1996). This follows a similar structure to Wajcman and Martin (2002) who used a questionnaire to explore the career patterns of men and women managers and semi-structured interviews to explore the way that managers made sense of their careers. The questionnaire and interviews are used to generate new insights into different aspects of women and men's experiences in engineering education in order to establish a multi-faceted understanding of the similarities and differences between women's and men's experiences. The research also incorporates a longitudinal perspective as a number of interview participants were interviewed before and during their industrial placement. A small number of participants also took part in focus groups on completion of their industrial placement.

The next sections of this chapter elaborate the methodology detailing each phase of the research in turn (interviews, questionnaire and focus groups) and includes discussion of why each data collection method was selected, access and selection issues, the data collection tools and a summary of data collected. The target population for all phases of the study were women and men undergraduate engineering students, with a particular focus on women students. Following this there is a description of the data analysis employed, ethical issues and concerns and an evaluation of the research.

4.5 Phase one: Interviews

Robson (2002) suggests that interviews are most appropriate: where a study focuses on the meaning of a particular phenomena to the participants; where individual perceptions of processes within a social unit are to be studied prospectively; where individual historical accounts are required of how a particular phenomenon developed; where exploratory work is required before a quantitative study can be carried out; where a quantitative study has been carried out, and qualitative data are required to validate particular measures or to clarify and illustrate meanings of the findings. Robson (2002) also suggests that the interview is a flexible and adaptable way of finding things out. Interviews offer the possibility of modifying the line of enquiry, following up interesting responses and

investigating underlying motives in a way that self-administered questionnaires cannot. Non-verbal cues can also add to the understanding of verbal responses. As Oliver (2003) points out, one of the primary aims of the interview is to map out the issues the interviewee defines as important.

The majority of data were collected through in-depth, semi-structured interviews, in order to uncover engineering students' thoughts and feelings about the cultures and structures of their education in their own dialogue. Interview data can generate large amounts of information quickly and immediate clarification is possible. Open-ended interviews also provide participants the opportunity to describe their feelings and experiences in their own dialogue. Qualitative interviews also provide the opportunity to follow up interesting ideas and to open up new dimensions, not previously anticipated (Murphy et al., 1998). Semi-structured interviews were selected over unstructured and structured interviews because respondents are not constrained by fixed answers, key topics are always included and usually responses can still be compared easily. Unstructured interviews, on the other hand, are unsystematic and difficult to analyse, while very structured interviews mean that responses can be constrained and there is a lack of rich data.

Interviewing does, of course, have its limitations that must be recognised. For example, cooperation is essential, participants may be uncomfortable with areas the interviewer wishes to explore, interviews may not be salient, the interviewer may not ask questions that evoke long narratives, participants may not be honest and data can be time-consuming to analyse.

4.5.1 Access and selection

The principle underlying sampling decisions were grounded in an empirical generalisation approach, due to an interest in establishing a typical example of women engineering students, rather than in building and testing theory, although this is not to say that theory was irrelevant to the research. Purposive sampling was undertaken of second year women engineering undergraduates, as students must decide in this year whether or not to undertake the industrial placement. Male engineering students were targeted whilst they were on their industrial placements. The industrial placement was specifically targeted to meet the objectives of the ESRC and engCETL funded projects which enabled the data collection for the research presented here. The placement is also usually student's first major contact with the engineering sector, and a key transitional stage in each student's process of becoming a professional engineer (or not).

Access to research informants was facilitated through gatekeepers in each of the engineering departments. Invitations to take part in the qualitative research were sent out to potential informants by email via industrial placement programme coordinators in the engineering departments. Such invitations, as suggested by Weiss (1994) explain: the role of the researcher; the purpose of the research; the purpose of the interview, and a summary of what would be included; and the extent to which anonymity and confidentiality would be guaranteed. The email also emphasised that individuals were not obliged to participate but that their assistance and cooperation would be very much appreciated. Oliver (2003) suggests that an email or letter invitation, rather than a cold call invitation by telephone for example, offers participants the opportunity to reflect on the information they have about the research and make an informed decision about whether or not they want to participate. By contrast if potential participants are approached in person, it may be difficult for them to refuse to take part (Oliver, 2003). Research participants were offered £10 compensation for taking part in research interviews. From this point, the interviewees were self-selecting, and while this may have resulted in a sample that is not representative of women and men engineering students generally, the range and number of interviews is broad enough to be indicative of students' experiences, particularly women's experiences, which form the major part of the sample. Further information about the individuals who took part in the interviews is provided in section 4.5.3 *Interview summary*.

4.5.2 Interview design

Interviews were conducted using a semi-structured interview guide and digital recorder. Whilst participants may feel constrained by the presence of a recorder, and recordings take time to transcribe, the benefits are vast. According to Weiss (1994) note-taking alone never captures exactly what a participant has said. Note-taking tends to simplify and flatten respondents' speech patterns, and content is likely to be lost if the participant speaks quickly. Note-taking also has the potential to interfere or inhibit interview proceedings (Marshall and Rossman, 1989). Furthermore, while an interview guide was used, it by no means acted as a constraint on the interviews.

The use of a semi-structured interview guide for the interviews meant that key issues identified by the researchers could be explored, while at the same time interviewees could define issues according to their own experiences and understandings. Within the context of the wider research projects, the interviews explored a range of issues, including, for example, influences and reasons for studying their chosen degree, experiences of their

learning environment, reasons for choosing/not choosing to go on placement, the transition to work, placement experiences, and future career intentions.

A copy of the interview guide can be found in Appendix A, although the figure below provides a summary and rationale for each of the interview topics. This interview guide also formed phase one of the ESRC funded research, which was followed up with a second interview while students were on their industrial placement (a copy of this interview guide has also been included in the appendix). The engCETL funded research, where data was collected from male students, used a combination of questions from the ESRC phase one and phase two interview guides.

Figure 4.2 Interview guide

Questions	Purpose
A. Introduction	To introduce the researcher and the purpose of the interview. Assure the interviewee of anonymity and right to withdraw from research. Request permission to record the interview. Offer opportunity for interviewee to ask any questions.
B. Background	Biographical information collected as comparators.
C. Pathway to Engineering/Career Decisions	To examine motivations for choosing to study engineering and how this related to career ambitions.
D. Engineering as Male Dominated	To explore whether women students are aware or concerned that they are a minority group and how this impacted on them; male students were asked whether they thought any particular groups were unrepresented in engineering and whether or not they thought this was significant.
E. Course Experiences	To determine the cultures and structures of engineering courses and how students experience this.
F. For Placement Students only	These questions were specific to the ESRC and engCETL projects and asked questions about what students' hopes and expectations for the placement were. Naturally the responses have some impact on how students' responses are interpreted.
G. For Non-placement Students only	These questions were specific to the ESRC project and asked the women students if they had considered going on placement.
H. Career	This section of questions also investigated how choice of study related to career ambitions.
I. Culture(s)	These questions concluded the interview and aimed to explore students' perceptions of engineering cultures generally.

4.5.3 Interview summary

Interviews were conducted with a total of 61 engineering students on various engineering courses at the university in the research. Two semi-structured interviews were conducted with a total of 21 women industrial placement students. The data presented here is primarily based on the first interviews which took place while women were in their second year of study. The second interviews took place the following year, when the students were on their industrial placements and were used primarily for the purpose of the ESRC funded research. The pre-placement interview stage of the research was complemented by including an additional 19 interviews with women second-year undergraduates who had chosen not to go on industrial placement. Finally an additional 21 interviews were undertaken using a combined interview guide for the engCETL funded interviews. These interviews were undertaken with 3 women and 18 male students during their industrial placements. The figure below shows a summary of the interview data and a more detailed summary of interviewees including, their pseudonyms, departments and the number of interviews they participated in can be found in Appendix B.

Figure 4.3 Summary of interview data

Summary	Total	Women	Men
Interviewees	61	43	18
Interviews	82	64	18
Placement students	42	24	18
Non-placement students	19	19	0
Aero & Auto Eng	11	5	6
Chem Eng	4	4	0
Civil & Build Eng	15	12	3
Design & Tech	13	10	3
Materials Eng	1	1	0
Mech & Manu Eng	17	11	6

4.6 Phase two: Questionnaire

Robson (2002) suggests that while questionnaires can be carried out for *any* research purpose, they are not well-suited to exploratory work, largely because open-ended questions are inefficient and ineffective. The most common use of questionnaires is to

generate description and information about a wide range of people characteristics and relationships between characteristics. Beyond this, it is also possible to use questionnaires to provide explanations of phenomena studied and the patterns of results obtained (Robson, 2002). Langdridge (2004) suggests that questionnaires are a particularly useful method for obtaining data from a large number of people. However, gathering data from a large number of people can be at the expense of the amount of information or detail collected. Fink (2006) states that questionnaires are a useful way of describing, comparing or explaining individual and societal knowledge, feelings, values, preferences and behaviour. Johnson and Turner (2003) also suggest that questionnaires are often used as part of the data collection process in multi-method studies.

4.6.1 Access and selection

The target population was all engineering undergraduates at the university where the research was carried out during October 2004. This totalled 3206 students from seven different departments. Access to students was gained through the university email system, using generic emails that are held for each year group on each course. The emails invited students to take part in the questionnaire which was attached to the email in a Word document. As with the invitation to participate in the interview phase, the email included various background information in order that students could make an informed decision about whether or not to complete the questionnaire. This information included: the role of the researcher; the purpose of the research; the purpose of the questionnaire; a summary of topics the questionnaire included; and the extent to which anonymity and confidentiality would be guaranteed. Having said this, the questionnaire did not explicitly state that the researcher aimed to compare findings on the basis of gender, as it was strongly felt that this would bias responses. However, given the fact that the questionnaire had a higher response rate from women than men, it may be that students' recognised this fact anyway. The email invitation also emphasised that individuals were not obliged to participate but that their assistance and cooperation would be very much appreciated. Research participants were, however, encouraged to participate in the questionnaire by the opportunity to be entered into a prize draw to win £50 of book tokens. Email was deemed to be an appropriate method of accessing students since most students within the university have regular access to email. Further information about the questionnaire responses is found in section 4.6.3 *Questionnaire summary*. It is entirely plausible that some students that participated in the interview phase of the research also completed the questionnaire.

4.6.2 Questionnaire design

The questions were designed to help achieve the goals of the research. The questionnaire was designed to ensure that responses to the questionnaire were accurate, exhaustive and mutually exclusive. This was achieved using a number of recommendations by Robson (2002: 245-246):

- Keep the language simple;
- Keep questions short;
- Avoid double-barrelled questions;
- Avoid leading questions;
- Avoid questions in the negative;
- Ask questions only where respondents are likely to have the knowledge needed to answer;
- Try to ensure that the questions mean the same thing to all respondents;
- Avoid a prestige bias;
- Remove ambiguity;
- Ensure the question's frame of reference is clear;
- Avoid creating opinions;
- Use personal wording if you want the respondents' own feelings;
- Avoid prior alternatives.

Most of the questions were closed questions (with differing response options) in order to ensure the questionnaire was quick and easy for respondents to complete. Closed questions also ensured that the data was easy to analyse in SPSS (see section 4.8 *Data Analysis* for more details) and complementary to the qualitative interviews and focus groups. Many of the questions used a five-point likert scale to allow respondents to express the extent to which they agreed or disagreed with various statements about career choice and experiences of HE.

A copy of the questionnaire can be found in Appendix C, but figure 4.4 details the main question topics and the rationale for including questions in each of these areas.

The data was also cleaned prior to analysis. This involved checking 5% of surveys entered into the survey software to ensure that data was entered correctly and producing frequency analyses and box plots to highlight false coding and potential outliers.

Figure 4.4 Questionnaire

Questions	Purpose
A. Career Choice	To investigate students motivations and influences in choosing to study engineering.
B. Experiences of HE	To examine students experiences of HE.
C. Industrial Placements	These questions were specific to the ESRC study.
D. Future in Engineering	To explore students career intentions and career motivations.
E. About You	To establish biographical information to be used for comparative analysis.
F. Additional Comments	To provide an opportunity for respondents to express any additional views or comments on the issues raised in the questionnaire.

4.6.3 Questionnaire summary

The questionnaire was sent to all undergraduate students, at the university where the research was implemented, registered on either an engineering or design and technology course in the academic year 2004/2005.

In total it was sent to 3206 students and 656 responses were received. This provided an overall response rate of 20.5%, although this varied by gender and by department as shown in figure 4.6. Nevertheless this is a robust response rate for qualitatively driven research and much higher than the 10% response rate achieved in Küskü et al.'s (2007) survey of engineering students.

As noted by Eysenbach and Wyatt (2002), use of a questionnaire can result in 'volunteer effect', whereby the individuals that complete the questionnaire may have a greater interest in the subject matter or perceive the subject to be particularly relevant to them. While the background information about the questionnaire did not make it explicit that the researcher was investigating gender differences, volunteer effect may explain the higher response rate from women students (35.3%) compared to men students (17.7%).

Figure 4.5 Questionnaire response rates[3]

	Total	Women	Men
Total engineering students	3206	434	2772
No. responses	656	153	491
% responses	20.5%	35.3%	17.7%
Aeronautical & Automotive students	493	34	459
No. responses	90	12	77
% responses	18.3%	35.3%	16.8%
Chemical engineering students	181	49	132
No. responses	44	17	26
% responses	24.3%	34.7%	19.7%
Civil & Building students	736	97	639
No. responses	97	25	70
% responses	13.2%	25.8%	11.0%
Design & Technology students	433	106	327
No. responses	102	37	64
% responses	23.6%	34.9%	19.6%
Electronic & Electrical students	470	43	427
No. responses	110	17	90
% responses	23.4%	39.5%	19.6%
Materials engineering students	125	18	107
No. responses	31	7	24
Mechanical & Manufacturing students	768	87	681
No. responses	177	37	137
% responses	23.0%	42.5%	20.1%

Figures 4.6 and 4.7 display the distribution of students by department and show that on the whole the questionnaire responses were reasonably well distributed across the different engineering departments.

[3] Figures may not add due to missing data. This means that some questionnaire respondents chose not to complete their gender and/or department.

Figure 4.6 Distribution of students among departments. N. 3206

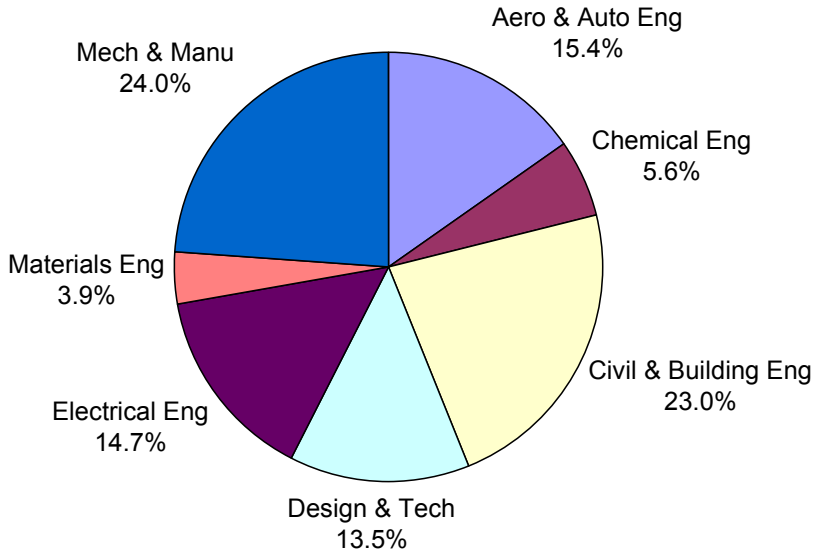
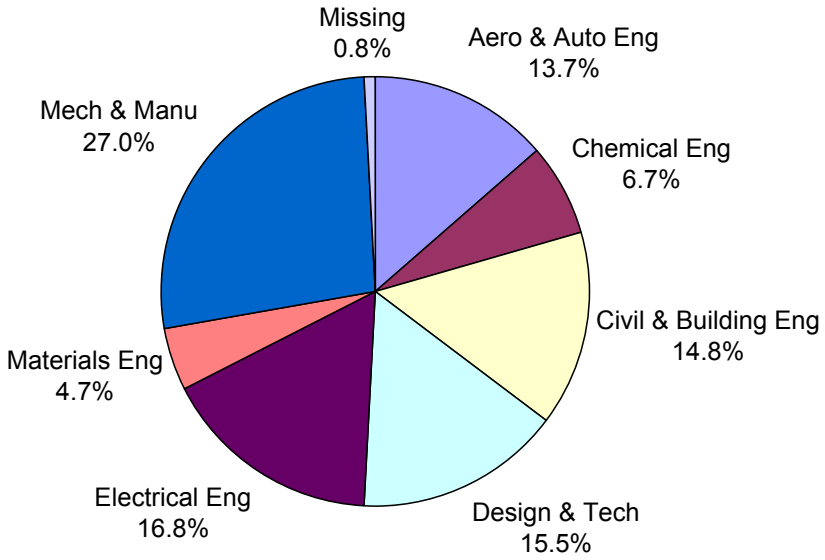


Figure 4.7 Distribution of respondents among departments. N. 656



4.7 Phase three: Focus groups

Focus groups are an opportunity for the researcher to learn through discussion, explicitly using group interaction as part of the data collection (Berg, 2007). Focus groups have previously been used as stand-alone strategies or in order to triangulate research findings (Berg, 2007). In this research, the focus groups were used to triangulate data, but this was not their sole purpose. Typically, focus groups consist of a small number of participants under the guidance of a facilitator. Krueger (1994) suggests that an optimum number of participants is seven, although Bloor et al. (2001) indicate that most texts recommend

between six and eight participants. Smaller focus groups carry a risk of limited discussion and risk of cancellation, while larger groups can be difficult to moderate and frustrating for participants if they do not have adequate time to express their views (Bloor et al. 2001). Vaughn et al. (1996) also argue that it is necessary to carry out at least two focus groups in order that the researcher can confirm the initial group's responses.

Berg (2007) suggests that the informal atmosphere of the focus group (in comparison to a one-to-one interview) is intended to encourage participants to speak freely. Focus groups are also useful for the dynamism they can create. Groups with an effective dynamic will allow participants to draw from one another's ideas or concerns (Berg, 2007). While focus groups may not provide such rich, detailed data as one-to-one interviews, focus groups provide an opportunity to observe participants interacting on a discussion topic. Berg (2007) suggests that meaning and answers arise in focus groups that are socially constructed, in a way that information from individual interviews is not. Interaction between focus group participants largely replaces the interviewer questions, and greater emphasis is given to the participants' viewpoints.

Bloor et al. (2001) argue that effective focus groups can generate more than just collective views on a topic. They suggest that they can produce data on the meanings, processes and norms behind the collective views. Focus groups can also give the researcher insight into the everyday language of the group since ideally the participants will be addressing each other, rather than the researcher, who is present to facilitate. They also suggest that focus groups have a role to play in complementing other research methods, for example, by providing a contextual basis for a questionnaire, to aid interpretation of a questionnaire, to communicate research findings, to generate new insights on earlier research findings. As such, focus groups could occur at the beginning, middle and/or end of a research project.

Bloor et al. (2001) also state that in focus groups the facilitator should aim to stimulate discussion, rather than seek answers to specific questions and suggests that 'focusing exercises' can be an effective way of concentrating the group's attention and interaction on a particular topic. This could include ranking exercises, vignettes, news bulletins or photo interpretations. Such exercises can be particularly useful as 'ice-breakers' and can ease comparison across focus groups. The facilitator's role should not be to over-lead the group. However, it is important they avoid individual members of the group over-dominating and encourage contributions from less vocal members.

Figure 4.8 Strengths and weaknesses of the focus group facilitator

Facilitator Strengths	Facilitator Weaknesses
Shows knowledge about the topic but not so much that participants are intimidated.	Relaying too much information at the beginning of the focus group
Demonstrates genuine incomplete understanding of the perceptions and attitudes of participants in order to elicit more detailed responses.	Being passive and not guiding the focus group.
Controls and leads the group but is also approachable and friendly.	Being too controlling and inhibiting genuine responses from participants.
Listens actively and willingly.	Promotes the participation of individuals unequally.
Is responsive to participants and does not follow preconceived ideas or adhere rigidly to the focus group guide.	Favours some participants' views over others.
Reacts with concern to the feelings and issues that participants express.	Fails to probe participants' responses, particularly when they could have multiple interpretations.
Does not allow individual members to dominate the group and encourages quieter participants to be involved.	Moves the discussion forward before all respondents have had the opportunity to participate.

Adapted from Vaughn et al. (1996)

Vaughn et al. (1996) also note that it is not an explicit goal of focus groups to reach a consensus. Furthermore, focus groups are designed to obtain people's opinions, but not to determine the strength of those opinions. Vaughn et al. (1996) also indicate that focus groups are best used for exploratory research and for ascertaining *why* people hold certain views. They can also be used to help interpret unexpected findings or provide verification of the interpretation of findings, or indeed to provide alternative explanations of findings.

4.7.1 Access and selection

All of the women engineering students who took part in the second set of interviews (conducted for the ESRC funded research while they were on their industrial placement) were invited to take part in the focus groups when they returned to university for their third year of study. Of the 21 women students invited, 13, almost two-thirds, accepted the invitation to take part in the focus groups. Of the students that declined to take part, most cited time as a deciding factor. The focus groups took place in the autumn semester

when students had coursework deadlines and some were also in the process of applying for jobs. However, since the focus groups aimed to raise issues concerning the industrial placement, it was felt that this was the most suitable time to conduct the sessions, since the memories of the placement would still be relatively fresh in the women's minds.

4.7.2 Focus group design

The focus groups undertaken in this research adopted a phenomenological approach, whereby the researcher had some initial knowledge of the issues (from existing literature and earlier data collection stages) and was interested in developing a more in-depth understanding (Vaughn et al., 1996).

Figure 4.9 Focus group prompt

Questions	Purpose
A. Introduction	To provide an overview of the purpose of the focus group and to introduce participants to one another (Vaughn et al., 1996).
B. Task	To set the tone of the focus group (Vaughn et al., 1996) and to act as ice-breaker (Bloor et al., 2001).
C. Probes	A limited number of key questions to guide the discussion and which encourage participants to express their opinions and feelings (Vaughn et al., 1996).
D. Other Questions	A number of secondary questions of less importance, but to use to stimulate further discussion if participants are not forthcoming.
E. Conclusion	To summarise some of the key themes raised in the focus group (Vaughn et al., 1996) and to thank group members for their participation in the research.

The purpose of the focus groups was to explore how women's attitudes and career intentions had changed as a result of their placement experiences, and to allow the women to compare and contrast their experiences. The women who took part in the focus groups were in their third year of university, having returned from their placements two to three months earlier. All of the women had taken part in the earlier interviews.

A copy of the focus group prompt can be found in Appendix D. However, figure 4.9 presents a summary and rationale of the issues covered within the focus groups.

4.8 Data analysis

Since the multimethod approach in the research is complementary, investigating different aspects of the same phenomenon, the analysis is presented in the findings chapters thematically, with multiple comparisons of the different datasets throughout. However, the initial analysis of the qualitative (interviews and focus groups) and the quantitative datasets (questionnaire) was carried out independently, as described below:

4.8.1 Qualitative data analysis

The interviews, with the agreement of the women, were tape-recorded and the focus groups video-recorded. All the data were then transcribed verbatim and anonymised, before being analysed with the computer software NVivo. NVivo was used to employ an approach informed by Grounded Theory, searching for meaning in the data and generating theory from rich, detailed descriptions in the interview transcripts. The initial analysis began with open coding, breaking down, examining, comparing, conceptualising and categorising the data (Strauss and Corbin, 1990); axial coding then ensured relationships between categories were systematically developed and that all similarities and differences were captured in the final analysis (Langdridge, 2004). The cumulative analysis of findings led to the eventual development of theories and explanations grounded in the data, reflecting the complex nature of the social phenomena investigated.

4.8.2 Quantitative data analysis

The questionnaire data was analysed using SPSS (Statistical Package for the Social Sciences). As noted above, the data was coded and entered into SPSS, where it was cleaned prior to starting the analysis. The initial analysis was univariate or descriptive and included generating counts, percentages, mean, standard deviation and range for each of the variables. The analysis presented in chapters five and six provides comparisons of responses by gender and departments, including the proportion of students who agreed or disagreed with various statements about career choice and experiences of HE and mean scores calculated from likert scale questions. Likert scale questions (for example, with optional responses: strongly agree, agree, neither agree nor disagree, disagree, strongly disagree) were converted into numerical scores (where, for example, one represents

strongly disagree and five represents strongly agree) in order to allow statistical comparison of means in the bivariate analysis.

As the primary objectives of the analysis were to compare the findings by gender and by department various bivariate analysis was carried out including independent samples t-tests (comparison of two means) and one-way ANOVAs (analysis of variants; comparison of more than two means). Both t-tests and ANOVAs are parametric tests used to test differences between groups (measuring the average means of two groups in the t-test and multiple groups in the one-way ANOVA) and to determine the probability that any differences between the groups are real and not due to chance (Fink, 2006). However, while a one-way ANOVA can reveal that there are significant differences between means, another test is necessary to determine where exactly the significant difference occurs among pairs of means (Langdridge, 2004). One-way ANOVAs were therefore complemented by the post-hoc Tukey HSD test to determine exactly where significant differences could be found between means. In addition the Kruskal-Wallis statistical test was used to interpret some data when a one-way ANOVA was not appropriate because the data was non-parametric (Langdridge, 2004).

4.9 Ethical issues

Ethical issues were addressed using the British Sociological Association (BSA) guidelines (2002), as well as current debate by various academics. Berg (2007) writes that because social scientists 'delve' into the lives of other people, they have an ethical obligation to their colleagues, their research participants and society in general. Researchers must ensure the rights, privacy and welfare of the people they are researching. However, Walliman (2006) suggests there are two aspects of ethical issues in research to consider: the values of honesty and personal integrity of the researcher and the ethical responsibilities to the subjects of the research, such as consent, confidentiality and courtesy.

4.9.1 Researcher integrity

Walliman (2006) suggests that honesty and integrity are necessary in research to maintain the trustworthiness and credibility of the research. The BSA (2002) ethical guidelines refer to this as 'professional integrity'. There are several aspects to this, which this research has strived to achieve:

- *Integrity of discipline:* the research strives to maintain the integrity of sociology as a discipline (BSA, 2002). For example, the data is available for future use by other researchers, as recommended by the BSA, through the publication of research findings and the submission of anonymised datasets to the ESRC data archive.

- *Intellectual ownership:* The work presented in this thesis is that of the researcher unless otherwise stated;

- *Citation and acknowledgment:* Where other researchers' work is cited, this is always acknowledged;

- *Responsibility and accountability:* This includes ensuring findings are reported accurately and truthfully and that the researcher has responsibility for how the data may be used in the future. To achieve this, this chapter of the thesis provides an accurate description of how the research was carried out. Full details of the research design and context of the study were also included with data submitted to the ESRC archive, to aid the understanding of any researchers using the data in the future;

- *Data and interpretations:* It can be easy to ignore or reject evidence that is contrary to the researchers' ideas or argument. However, objectivity has been maintained as far as possible, including making a particular effort to identify contrasting evidence;

- *Philosophical background:* The epistemology and ontology of the researcher have been established at the outset of this chapter, in order that the reader can understand the assumptions on which the research is founded.

4.9.2 Ethics and research participants

It is the responsibility of the researcher to address the impact of the research on the research participants. The researcher should recognise that the pursuit of knowledge must not adversely affect the rights of research participants (BSA, 2002). There are several facets to this (Walliman, 2006):

- *Use of language:* The research aimed to use neutral language and to avoid being patronising, disparaging, biased, stereotyping, discriminating, marginalising, intolerant and male centric.

- *Choosing participants:* While participants were encouraged to take part in the research, care was taken not to exert pressure on participants to take part;

- *Freedom from coercion:* Oliver (2003) states that some researchers may feel that inducement or compensation for participating in research could change the researcher/participant relationship or distort the way data is provided. However, Oliver (2003) also argues that giving up time to take part in research could be seen as no different to giving up time to work at anything else, in which case it may be reasonable to offer participants payment. While participants were encouraged to take part in the research with £10 for taking part in interviews and a £50 prize draw for completing the questionnaire, this was not intended to act as a reward to participants, but rather a commensurate recompense for the time and inconvenience of participating in the research. It was not felt that payment unduly influenced participants responses given the variety of opinion expressed in the interviews and focus groups. Furthermore, while participants were informed that they would be compensated £10 for their time in taking part in the interviews, some interviewees seemed to be surprised or have forgotten that they were receiving compensation for their participation.

- *Gaining consent:* The BSA (2002) states that participation should be based on informed consent. This means that researchers should explain the purposeof the research, who it is for and how it will be used. Berg (2007) writes that getting informed consent means the knowing consent of individuals to participate in the research, free from any element of fraud, deceit, duress, unfair inducement or manipulation. Typically, consent is ensured in writing through informed consent slips, which contain a written statement of potential risk and benefit. This ensures that the research participants are knowingly involved in the research and do so of their own choice. However, this can also be problematic, given that it means there is a written record that the participant took part in the research. Sometimes implied consent is used to replace written consent, whereby consent is implied by the fact that the participant has taken the time to complete a questionnaire or participate in an interview. In this situation the purpose and potential risks and benefits of the research are explained at the outset. Interview participants were provided with some background information about the research in order that they could make an informed choice about whether or not to participate in the research. Initially information was provided in the emails inviting students to participate and additional information was provided at the start of the interviews, where students were also offered the opportunity to ask the researcher any questions they might have.

- *Potential harm and gain:* Researchers have an obligation to consider the consequences of the research on participants and to protect the rights of participants (BSA, 2002). In

this study, no harm was perceived to exist for the participants in terms of their reputation, dignity or privacy.

- *Storing and transmitting data:* The BSA (2002) states that research data should be stored in a secure manner and in accordance with the Data Protection Act. All data, both paper-based and audio, were kept in a locked filing cabinet and computer databases were password protected. In addition all interviewees were given pseudonyms and identifiers, such as names of people and places, were removed from transcripts.

- *Confidentiality and anonymity:* It is essential that participants understand the extent of confidentiality and anonymity (BSA, 2002). Berg (2007) states that confidentiality and anonymity are often used synonymously, despite having distinct meanings. Confidentiality, Berg suggests, is the active attempt to remove any elements from the research that may indicate the participants' identity. Anonymity on the other hand, means that participants remain nameless. In most qualitative research, however, the participants are known to the researcher, and hence anonymity is problematic. Oliver (2003) suggests that the use of fictional names can go some way to ensure anonymity without making the data impersonal. As such participants in the interviews and focus groups were all given pseudonyms, as was the university where the research was conducted. Anonymity was also extended to any individuals or places mentioned by interviewees. This was not only to protect those mentioned but to prevent the people and places mentioned being used to identify the interviewees. Focus groups were not, however, anonymous at the point of implementation, since by their nature they involve a group of participants who will be able to identify each other. However, participants were informed of the nature of this part of the research when they were invited to participate and were also asked to keep the content of the focus group confidential. This did not appear to impact on participants willingness to disclose information during the focus groups.

- *Recording interviews:* Participants should be aware that it is entirely their decision whether their interview is tape-recorded and the researcher should explain the purpose of both recordings and field-notes (BSA, 2002). Oliver (2003) points out that the use of the tape recorder may be intimidating or inhibiting for some research participants. The researcher explained the purpose of recording interviews and requested permission to record the interviews from all interviewees. Only one interviewee requested not to have their interview recorded and this was entirely respected. Research notes were taken in all interviews, although these were much more detailed in the interview which was not

recorded. However, other problems did occur with regard to the use of recording interviews. For example, one interview failed to record and a number of participants divulged additional information after recording had finished. Whether this was entirely a result of recording is uncertain, as some interviewees may also have had additional views to express once the more formal questions or interview guide had been completed.

- *Right to withdraw:* The BSA (2002) states that participants have the right to refuse participation at any point in the research process. All research participants were made aware of their right to withdraw from the research or to decline to answer any questions with which they were uncomfortable. Having said this, no-one withdrew during the course of an interview and while some interviewees did not answer some questions this appeared to be because they did not have an answer, rather than because they were uncomfortable with the line of questioning. It is also unlikely that participants felt compelled to take part in the research from interview one to interview two to the focus groups as there was a small drop-out between interviews one and two and a large drop out between interview two and the focus groups. The lack of participation in the focus groups was also because of competing pressures on the interviewees, for example in terms of coursework deadlines. However, the timeliness of the focus groups, when students first returned to university following their placement, was felt to supersede the necessity to include a large number of participants in the focus groups.

Whilst ethical dilemmas are an unavoidable consequence of fieldwork, such dilemmas were minimised by taking a number of precautions, most of which have been outlined above. To summarise, key actions taken included gaining voluntary and informed consent from all research participants. Potential respondents were given sufficient information about the research and their role before they were asked to participate. Participants were told that their consent did not compel them to do, or talk about, anything with which they did not feel comfortable and that they could withdraw from the research at any time. Research participants were also granted anonymity, and were given pseudonyms from the beginning of the research. The provision of evidence in both this thesis and other published documents is unattributable to individuals.

4.10 Evaluation of research

This section addresses the trustworthiness of the research, focusing for example on the accuracy, replicability and generalisability of the data. While as interviewers we can anticipate that we will be told the truth, Weiss (1994) suggests that we cannot assume that

we will be told the whole truth or the precise truth. If informants want to keep events or behaviour from the interviewer there is every reason to believe that they can succeed. While it would be difficult for respondents to produce circumstantial detail and corroborating evidence necessary to make an invented reality seem plausible, it is very easy for participants not to report something and to give no indication that there is something not being reported. Nor can we be sure we will be told the precise truth. The uncertainty of respondents memories make for reports in which some observations are crystal clear while others are obscured or distorted or blocked (Weiss, 1994). This is especially likely when participants are asked about opinions, attitudes, appraisals, evaluations, values or beliefs. Weiss (1994) maintains that while questions about concrete incidents may be answered from more than one perspective, they are less likely to be modifiable by the interviewing context. Thus we will obtain more reliable information and information easier to interpret if we ask about concrete incidents than we will if we ask about general opinions. Wherever possible, questions were framed in the context of specific incidents in order to increase the value of participants' responses. It is also useful to note that inconsistency in respondents' accounts does not always demonstrate invalidity. After all, people can act in an inconsistent or illogical manner and can maintain conflicting feelings (Weiss, 1994).

It is also intended that the trustworthiness of the research has been increased by reflecting upon the impact of the researcher on the research findings. Whilst it is hoped that this impact has been minimised, there is '*no way in which we can escape the social world in order to study it*' (Hammersley and Atkinson, 1995: 17). Although the researcher's impact on the research can be controlled, it is still important to recognise the ways in which the researcher has contributed to the data collected and their own *apriori* assumptions have shaped the data analysis (Murphy et al., 1998). It is also intended that attention to negative cases and alternative explanations of the findings will add to the validity of the research.

Trustworthiness of this research has been maximised through the presentation of data collection methods (for example, how access to respondents was achieved); this allows the research data to be understood in relation to the context of their production and enables the reader to judge the research, taking account of the process by which the researcher arrived at their conclusions (Murphy et al., 1998). Similarly, the exposition of the data analysis process allows the reader to make informed judgements of the research. This is significant because the adequacy of any analysis depends upon the nature and quality of the process that is used to organise and interpret the data upon which it is

based (Murphy et al., 1998). In other words, the detailed methodology presented, explained and justified in this chapter increases the transparency of the research.

In terms of the generalisability of the research, it is important to note, as stated earlier, that this research adopts a predominantly qualitative approach to explore and develop an understanding of women's experiences of engineering HE cultures, rather than measuring and quantifying their experiences. While a questionnaire was also conducted, this was intended to complement the qualitative data. Nevertheless, the questionnaire achieved a robust response rate (20.5%), higher than similar studies (e.g. Küskü et al., 2007), indicating that it is representative of women and men engineering students' views.

4.11 Summary

- This chapter has addressed the methodology of the research.
- The main aim of the research is to examine the relationship between HE engineering cultures and women engineering students' gendered and professional identities, as well as exploring whether women challenge or maintain existing engineering cultures.
- The research is informed by an interpretivist epistemology and constructivist ontology, which aims to reveal how women engineering students interpret and understand their experiences. This is achieved using a multi-method approach.
- The data was collected in three main phases:
  1. Semi-structured interviews with women and men engineering students.
  2. A questionnaire sent to all engineering undergraduates at the university in the research.
  3. Focus groups with third year women engineering students who had completed an industrial placement.
- Students were accessed primarily through departmental placement coordinators and the university email system.
- Qualitative data analysis was informed by grounded theory and aided by the use of the software NVivo. Quantitative analysis was implemented using SPSS to generate univariate and bivariate analysis.
- Ethical issues were a key concern throughout the research and various methods were employed to maintain the integrity of the researcher and to protect the research participants.
- The research has been evaluated in terms of its accuracy, replicability and generalisability.
- The next two chapters thematically present the key findings from the research, combining the analysis of the qualitative and quantitative datasets.
- Chapter five, *Women Engineering Students and Career Choices*, is primarily focused on the career choices of engineering students.
- Chapter six, *Women's Experiences of Higher Education*, addresses engineering students' experiences of HE.

5. Women Engineering Students and Career Choices

This chapter of the thesis sets out to examine women engineering students' career choices, looking specifically at how women choose to study engineering and whether the decisions involved in this are gendered. The chapter also addresses whether there are any differences on this issue with regard to the engineering discipline women are engaged in. In the context of the aims and objectives, career choice is investigated since it may reveal the extent to which women are committed to a career in engineering, whether women perceive there to be any conflict between being a woman and being an engineer and, how these experiences and attitudes relate to the construction of women's identities. The analysis draws on data from both the qualitative and quantitative datasets, with comparison of the findings from each throughout.

The data analysis revealed several key themes relating to career choice among women engineering students, which are explored in detail below. These themes have been developed using some of the career choice models outlined in the literature and are: socialisers; knowledge of engineering professions; skills, ability and attributes; career rewards; identity; choosing a degree course not a career; and, perceived barriers to engineering for women. These themes are not, however, mutually exclusive, and almost all intersect, as will be revealed as the themes are explored. Furthermore, in the interviews, the interviewees expressed a different combination of factors and influences impacting on their career choices.

5.1 Socialisers

Socialisers are considered to be key people and experiences that have influenced students' career decisions.

5.1.1 Parental influences

Students shared how their parents shaped their interest both in specific hobbies or highlighting engineering as a possible career choice. Within this, there was often a distinction as to whether it was students' mothers or fathers that had influenced them, although fathers were more likely to be cited as an influence in terms of technical hobbies:

> *I think it's very much my Dad's influence … he used to take me model car racing and model airplane flying from a very early age.*

Emily, Aeronautical & Automotive engineering student

I think he [father] *influenced me in the way that he has a passion for engineering, so it kind of encourages you to think about engineering. And with dad, there's a lot of stuff in the garage and he always let me go and play with it, but not in the sense that 'you're going to do engineering at university', you know what I mean? He wasn't like that.*

Holly, Mechanical & Manufacturing engineering student

In the questionnaire 31.2% of students agreed that their father encouraged them to study engineering. While a further 31% disagreed with this. There was no significant difference by gender or departments. The questionnaire also indicated that 20.2% of students had been encouraged to study engineering by their mother, while 37.9% disagreed with this. Again statistical analysis showed there was no significant difference by either gender or department.

Parents were also seen as instrumental as a source of information about engineering, without which students may not have known that engineering was an option (this is also strongly related to awareness of the engineering professions as influencing career choice and is discussed further below):

I decided to do something to do with construction, basically because my dad had a construction firm at one point.

Anna, Civil & Building engineering student

I think my mum originally suggested it, because I hadn't really heard much about engineering.

Andrea, Civil & Building engineering student

I didn't really know what I was going to do, sort of university wise. And my mum, she got a job with CITB, and so she kind of knew all about the construction industry. She kind of thrust some leaflets under my nose and said what about this job?

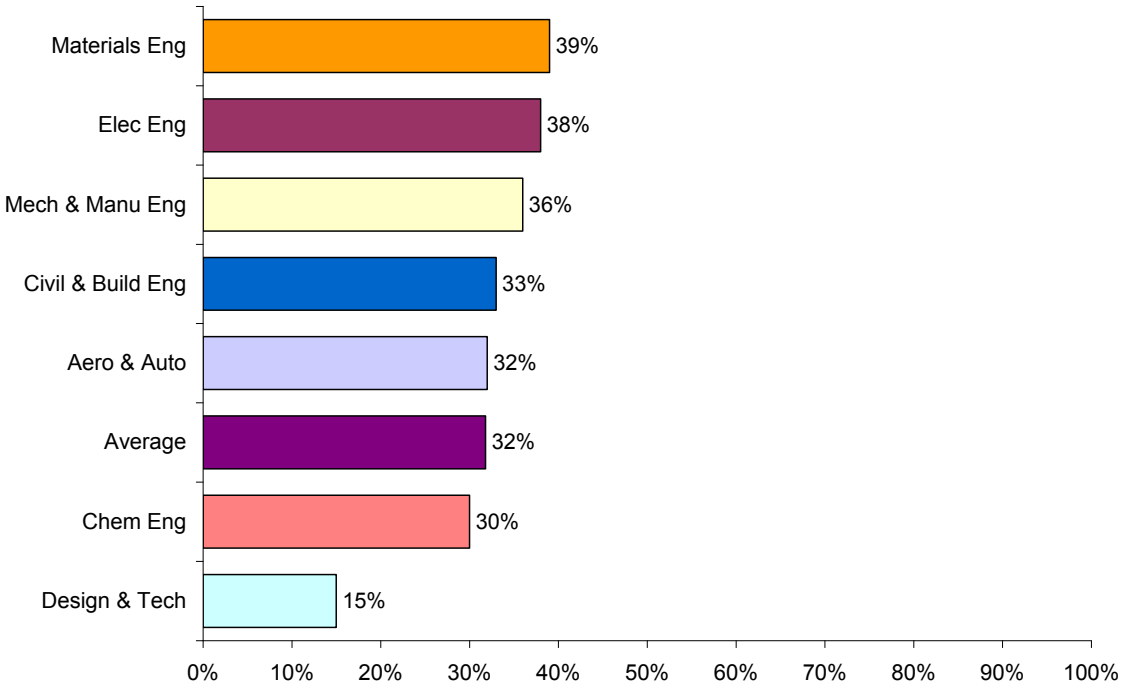
Debra, Civil & Building engineering student

My dad was an engineer and my mum was an artist so that's why I kind of went into design. I guess I got a lot of influence from home.

Matthew, Design & Technology student

As shown in figure 5.1 these comments were supported by the questionnaire which showed that 31.8% of students agreed that they knew about engineering because a member of their family is involved in the industry, although a further 57.5% disagreed with this statement. An independent samples t-test showed that there was no significant difference in this by gender. However, an independent one-way ANOVA showed that the department students belong to can have a significant effect on whether they knew about engineering because a family member is involved in the industry ($F=4.03$, $df=6, 644$, $p<0.01$).

Figure 5.1 Proportion of students that agree they know about engineering because a member of their family is involved in the industry, by department



Employing the Tukey HSD, there was a significant difference between Electronic and Electrical engineering and Design and Technology ($p<0.01$) and between Design and Technology and Manufacturing and Mechanical engineering ($p<0.01$). While Materials engineering students had the highest proportion of students in agreement with this statement, the statistical comparison also considers the proportion of students neither agreeing nor disagreeing, and disagreeing, as well as the proportion of students in each

department. Furthermore, while the tests do not show 'significant' differences, this does not mean that the differences shown are unimportant.

In contrast to the support of parents in choosing to study engineering, some women students chose to study the subject despite their mothers' reluctance or hesitancy:

> *She* [Mother] *thought I should be doing Maths or Accounting, because she thought there was better job prospects and the course wouldn't be as heavy, so I'd find it easier.*
>
> Hayley, Mechanical & Manufacturing engineering student

> *My mother actually said it could be quite tough for a girl to do civil engineering.*
>
> Michelle, Civil & Building engineering student

5.1.2 Childhood experiences

Childhood experiences were found to be influential among students in stimulating an interest in activities and hobbies traditionally thought of as masculine and technical focused. Arguably such factors and experiences result in individuals being orientated or biased towards particular careers in this case engineering:

> *As a kid I always sort of played with technic lego and stuff like that.*
>
> Emma, Mechanical & Manufacturing engineering student

> *The thing is with the way I was brought up, going to like model shows and you know model flying, quite often I was the only girl in the building.*
>
> Emily, Aeronautical & Automotive engineering student

> *Engineering, I would say it's probably in my blood to be honest. It's kind of been the natural progression for me. When I was like really young I used to mess around with my granddad in the garage and I used to take all of my toys apart and it was generally ingrained in me that I was going to go into engineering.*
>
> Mark, Mechanical & Manufacturing engineering student

From an early age I found that I was quite good with my hands and quite inquisitive as to how and why things worked.

Paul, Aeronautical & Automotive engineering student

It's a growing up thing; it's what you play with when you're a kid. My parents basically dressed me in boy's clothes. My dad's a nurse, so that's a girl's job so…, so he never ever enforced somebody to do a kind of boy/girl thing. And I had trains and Lego and I don't know if that's anything to do with why I'm doing this now, but maybe it does, I don't know.

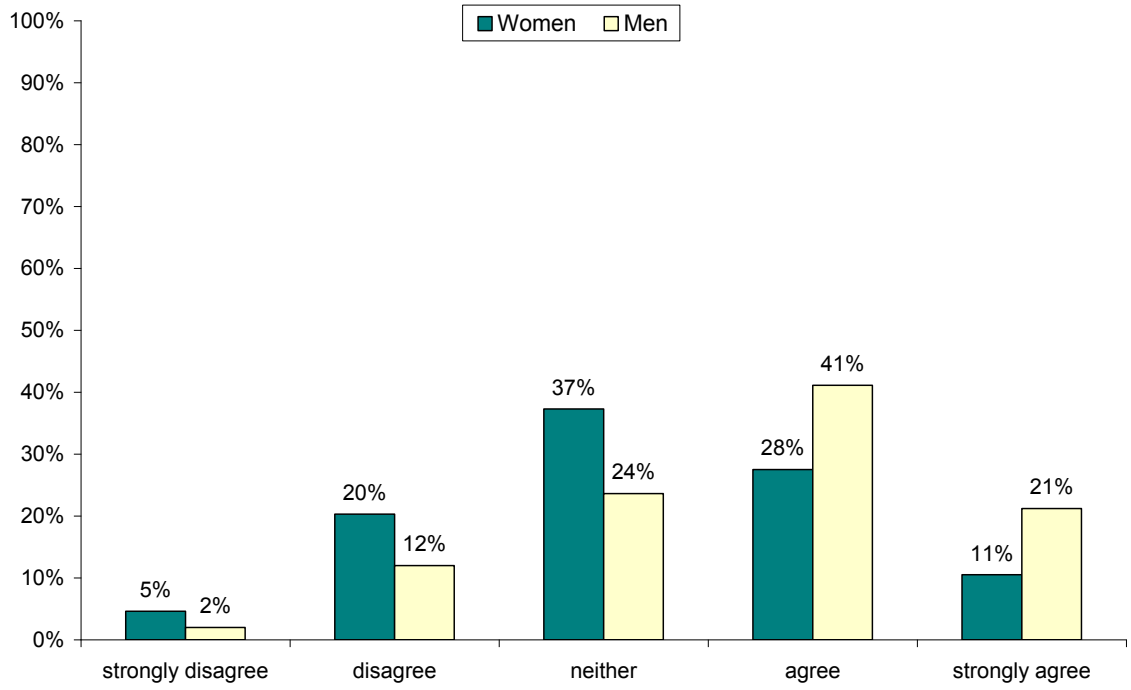
Samantha, Civil & Building engineering student

I had an older brother, my mum was like 'no point in buying two sets of toys: have this!' So I always used to have boy's stuff.

Jessica, Design & Technology student

These quotes also highlight students' perceptions of certain behaviours and toys as gendered, in that things like lego and model planes are seen as 'boys toys', despite the fact that as girls, they were also interested in these things.

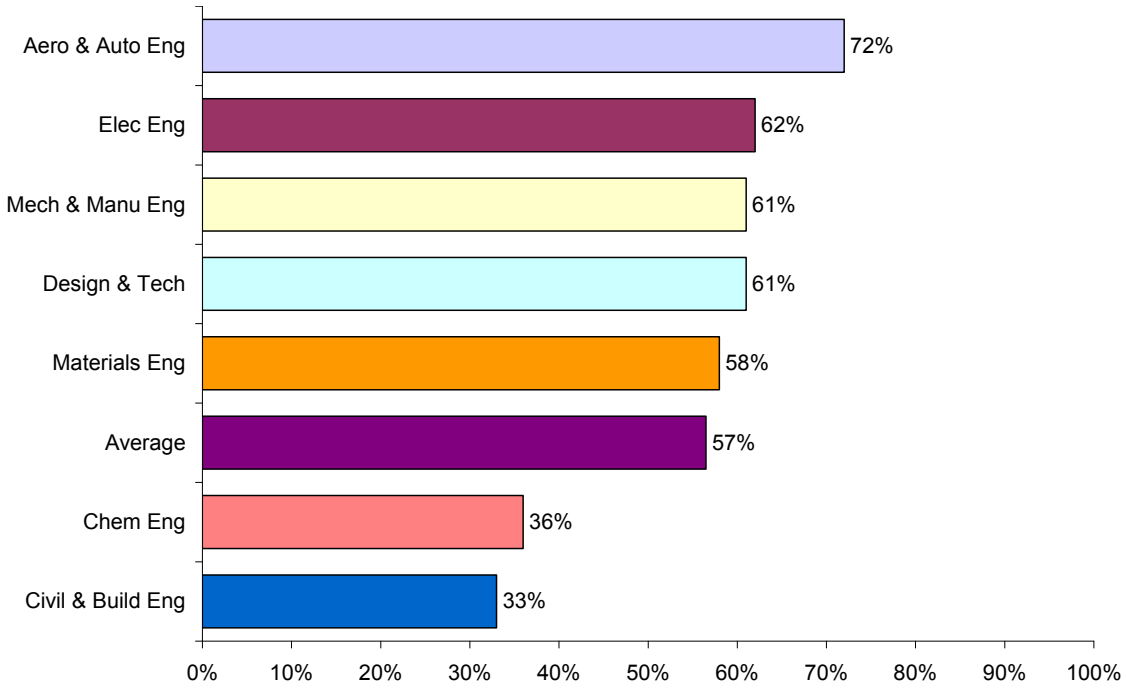
Figure 5.2 Proportion of students who agree that their hobbies and interests are of a technical nature, by gender



The questionnaire supported these findings: 56.5% of engineering students agreed that their hobbies and interests are of a technical nature. This varied by gender, as shown in figure 5.2 above. The mean score for men whose hobbies and interests were of a technical nature (M=3.67, SD=1.0) is significantly higher (t=5.19, df=642, p<0.01) than that for women whose hobbies and interests are of a technical nature (M=3.19, SD=1.05).

An independent one-way ANOVA showed that the department students study within also has a significant relationship on whether their hobbies and interests are of a technical nature (F=6.40, df=6, 644, p<0.01). This is also shown in figure 5.3, which indicates that 72.2% of Aeronautical and Automotive engineering students agreed that their hobbies are interests are of a technical nature, compared to only 33.0% of Civil and Building engineering students.

Figure 5.3 Proportion of students who agree that their hobbies and interests are of a technical nature, by department



Employing the Tukey HSD, there was a significant difference between Aeronautical and Automotive engineering and Chemical engineering (p<0.05), between Aeronautical and Automotive engineering and Civil and Building engineering (p<0.01), between Electronic and Electrical engineering and Civil and Building engineering (p<0.01), between Civil and Building engineering and Mechanical and Manufacturing engineering (p<0.01) and between Civil and Building engineering and Design and Technology (p<0.01). Students from Civil and Building engineering are less likely to agree that their hobbies are of a

technical nature (M=3.07, SD=1.0) compared to other students (M=3.56, SD=1.03). The issue of childhood experiences also raises interesting questions about how children are socialised into particular roles, and may be an area for further research.

5.1.3 Influence of teachers

As well as parents and childhood experiences, school teachers were also found to have a strong influence on the choices of engineering students. A teacher's ability to engage students in a subject can help motivate student interest in a subject, but students also expressed that teachers had a much more explicit influence over them, highlighting engineering as an option for students to consider (this also links to students' awareness of the engineering professions, which is discussed further below):

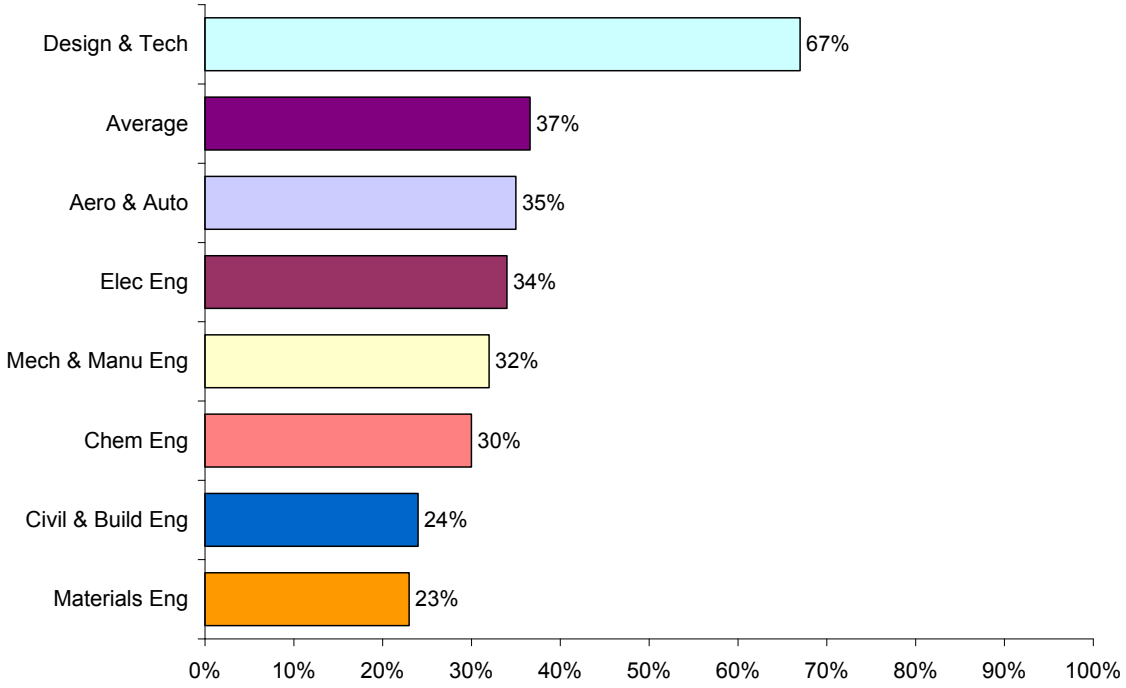
> *I mean my technology teacher did the same thing and actually came to* [the University] *and he talked to me a bit about the background and what it was like.*
>
> Amanda, Design & Technology student

> *My physics teacher at 'A' level was really good and I went* [and] *spoke to him and said, 'look, these are the bits I've enjoyed, what do you suggest?' And he suggested civil engineering and I looked into it a bit more.*
>
> Eve, Civil & Building engineering student

> *My physics teacher was an aeronautical engineer, so she's the one that suggested doing it and pushed it.*
>
> Tracey, Aeronautical & Automotive engineering student

In the questionnaire, 36.3% of students agreed that they were encouraged to study engineering by their school teacher(s), although an additional 27.9% disagreed with this statement. Statistical comparisons showed that there was no significant difference between men and women. An independent one-way ANOVA showed that the department students belong to has a significant relationship with whether students' school teachers encouraged them to study engineering ($F=9.66$, $df=6, 641$, $p<0.01$). As shown in figure 5.4, 66.7% of Design and Technology students agreed that they were encouraged to study the subject by their school teacher(s), compared to only 23.3% of Materials engineering and 24.0% of Civil and Building engineering students.

Figure 5.4 Proportion of students who agree that their school teacher encouraged them to study engineering, by department



Applying the Tukey HSD, there was a significant difference between Design and Technology and all other departments ($p<0.01$). Design and Technology students were more likely to agree that their school teacher(s) encouraged them to study engineering ($M=3.74$, $SD=1.12$) compared to other students ($M=3.04$, $SD=1.24$). This finding is probably explained by the fact that Design and Technology is a distinct school subject, whereas the engineering disciplines are only likely to be taught as part of science and mathematics classes, if at all.

5.2 Knowledge of the engineering professions

This section discusses findings concerning students' knowledge and lack of knowledge about the engineering professions with a particular focus on the usefulness of careers advice, general awareness of the industry, and the role of insight courses.

5.2.1 Careers advice

A number of students were critical of their school careers advisors, and felt that they had discouraged them from studying engineering. This was a particular issue for women students, rather than men:

They weren't really enthusiastic about engineering. They tried pushing me towards teaching or something like that and I said no, I wanted to do engineering.

Stacy, Aeronautical & Automotive engineering student

I remember going to a careers interviews about what you would do at university and it was like: 'I think I'll do engineering,' and it was like 'oh, you are good at maths and science. Why don't you do accounting or physics or you can go and be a doctor or if you want to do engineering then you can do physics and then go on and do something else.' It was like, 'well why can't I do engineering?' He was saying, well it's an option but you could do all this as well.

Hayley, Mechanical & Manufacturing engineering student

However, by contrast, some students felt that their careers advisors, similar to parents and teachers, had highlighted engineering as an option for study at university, even if the students may not have agreed with the careers advisor at the time of their meeting:

When I was at school, the careers people said, 'what are your favourite subjects?' I said, 'maths and physics', and they said, 'OK look at engineering', and I said, 'no'. I'd never looked at it and it just didn't interest me, but one day I looked at a prospectus and it looked really good.

Erica, Mechanical & Manufacturing engineering student

I went to see a careers advisor and she said, 'have you thought of engineering?' And I was like, I don't even know what that is.

Samantha, Civil & Building engineering student

I was basically told by the careers officer at school that with the sort of level I was at [in maths and physics] *I could do quite well in engineering.*

Craig, Aeronautical & Automotive engineering student

Other students had already set their minds to studying engineering and felt that they did not need careers advice:

I didn't need careers advice. I was quite set on where I wanted to go.

James, Aeronautical & Automotive engineering student

The questionnaire findings were reasonably split in terms of the influence of careers advisors: 36.3% of students believed that they were encouraged to study engineering by their careers advisor(s), however a similar proportion (37.3%) disagreed with this statement. There was no significant difference by gender or department.

5.2.2 Awareness of engineering professions

Building on the idea of parents, teachers and careers advisors raising engineering as an option for students, friends and other family were a key source of knowledge about the sector and job opportunities that were available for both women and men students:

> *Two of my best mates are at Southampton doing engineering. My dad took civil engineering at Cambridge* [and] *I think my uncle's a mechanical engineer of some sort. So, yeah, I've had quite a few dealings* [with people] *who had an engineering background.*

James, Aeronautical & Automotive engineering student

> *My dad's an engineer and a few friends at school have majored in engineering and that may have given me a bit more confidence to do it.*

Jackie, Mechanical & Manufacturing engineering student

> *I knew quite a few people who'd done aeronautical engineering particularly, who'd gone through it all beforehand and they were nothing but supportive. The only thing they did say was just be aware of what you're letting yourself in for, because it is really, really hard work.*

Jenny, Aeronautical & Automotive engineering student

However, both the interviews and questionnaire also indicated that for many people, especially women, there is a lack of knowledge about the engineering sector:

> *I hadn't really heard much about engineering. It was sort of something that existed in the sub-conscious somewhere, you don't really actively think about it.*

Andrea, Civil & Building engineering student

I wasn't that clued about what engineering was about, I knew it was a lot of maths and a lot of physics, so I knew I'd get on with it, but I didn't really understand what it was.

Jenny, Aeronautical & Automotive engineering student

I didn't really know about it till I got here, I just thought like building stuff, but the amount of thought that goes into it, and design and it's just the whole like thermodynamics and fluids, well…

Stacy, Aeronautical & Automotive engineering student

I didn't really know an awful lot about it till I started it so it was just a fluke really, I think.

Amy, Mechanical & Manufacturing engineering student

I don't really know because I didn't really come with any expectations as it were. I mean it may sound a bit silly but I didn't really know what I was letting myself in for.

Hannah, Civil & Building engineering student

I didn't know 100% what engineering's all about until I did it myself and I spoke to those people who have already graduated.

Kelly, Chemical engineering student

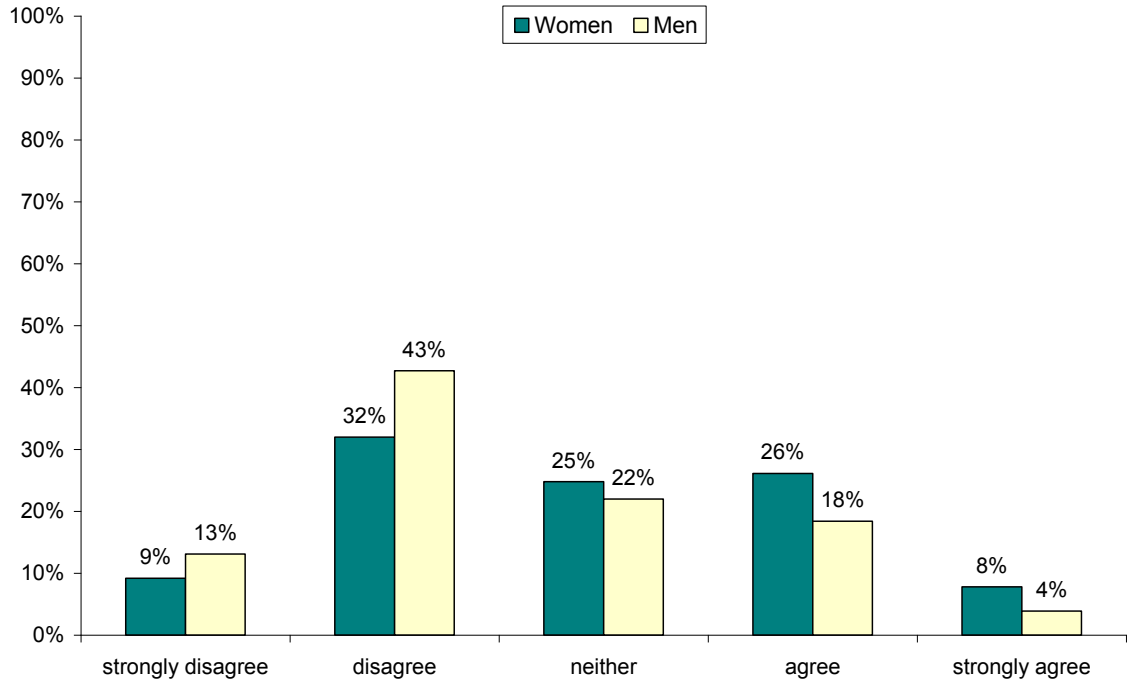
I just didn't even think about engineering, I didn't know what it was, so it wasn't really an option.

Rebecca, Design & Technology student

These findings indicate that many women students appear to find themselves studying engineering more as a result of luck than judgement and are supported by the questionnaire, where a worrying 24.9% of respondents agreed that they has chosen to study engineering with little knowledge of what engineers actually do. The mean score for women who chose to study engineering with little knowledge of what engineers actually do ($M=2.92$, $SD=1.12$) is significantly higher ($t=3.45$, $df=641$, $p<0.01$) than that for men ($M=2.57$, $SD=1.05$). In total 33.9% of women agreed or strongly agreed that they chose to study engineering with little knowledge of what engineers actually do, compared to 22.3%

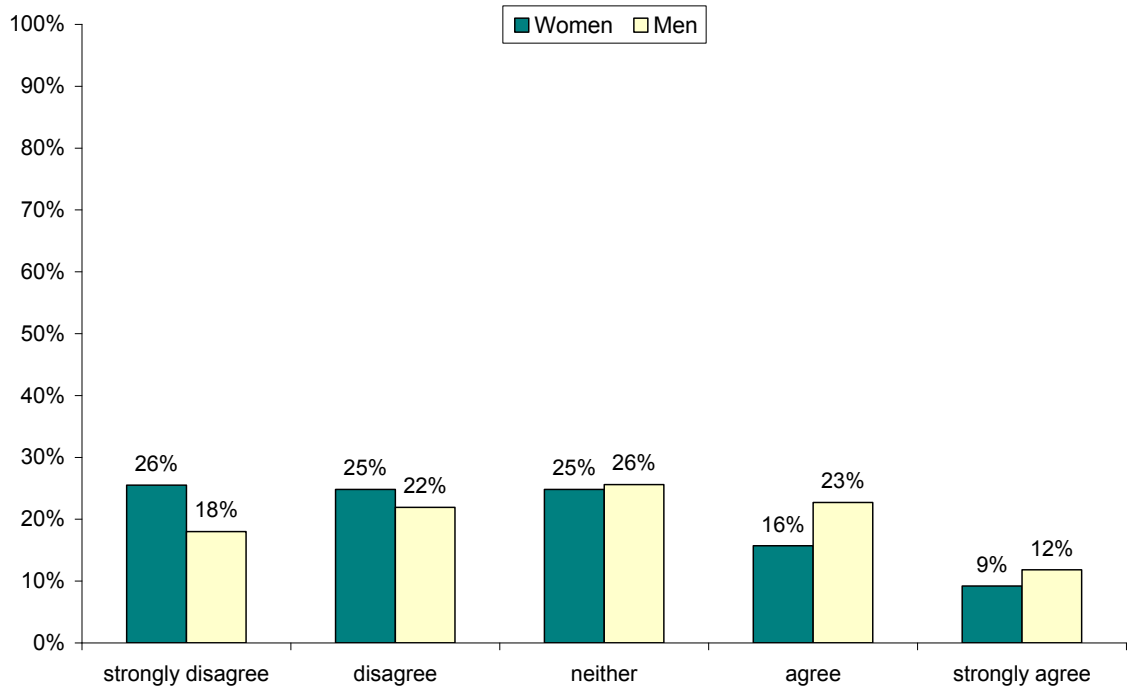
of men (see figure 5.5). However, there was no reflection on what they thought engineering might be beyond the comments related to the opportunity to use their maths and science ability and practical skills.

Figure 5.5 Proportion of students who agree they chose to study engineering with little knowledge of what engineers actually do, by gender



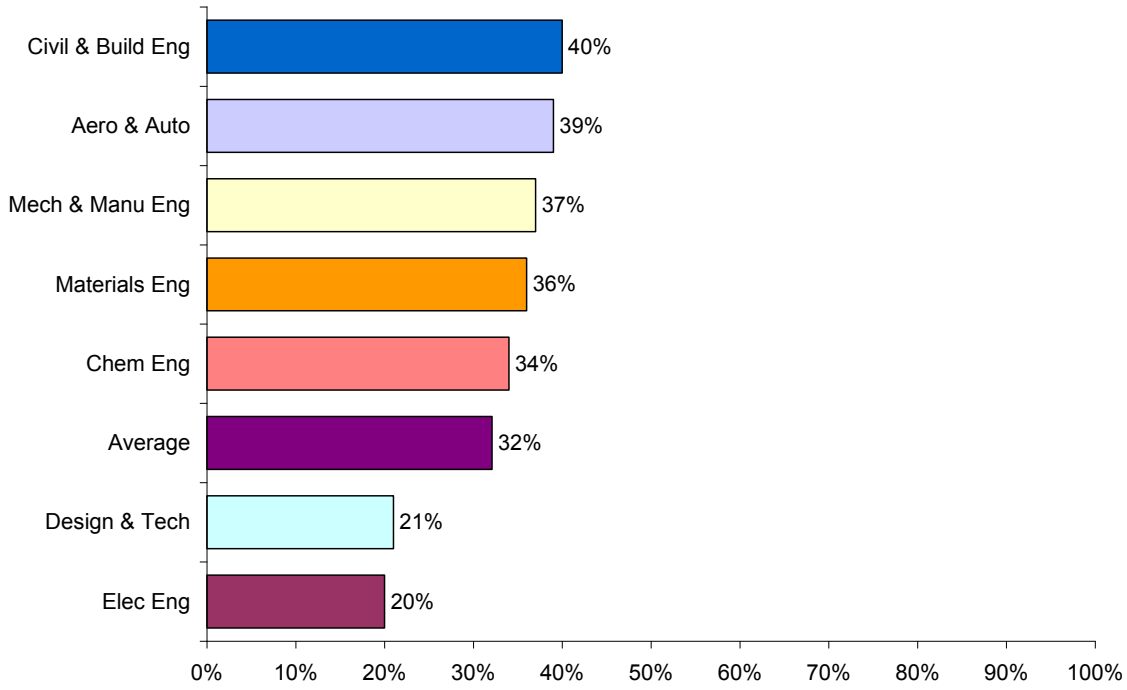
Interestingly, 32.1% of students stated that nobody encouraged them to study engineering. An independent samples t-test showed that this differed significantly by gender ($t=2.56$, $df=635$, $p<0.05$). Men were more likely to have nobody encourage them to study engineering ($M=2.88$, $SD=1.28$) than women ($M=2.58$, $SD=1.28$). As shown in figure 5.6, 34.5% of men agreed or strongly agreed that nobody encouraged them to study engineering, compared to 24.9% of women. This strongly implies that in order to study engineering women need to be encouraged much more than men.

Figure 5.6 Proportion of students who agree that nobody encouraged them to study engineering, by gender



An independent one-way ANOVA showed that the department students belong to also has an impact on whether nobody encouraged them to study engineering ($F=2.81$, $df=6, 637$, $p<0.05$).

Figure 5.7 Proportion of students who agree that nobody encouraged them to study engineering, by department



For example, as shown in figure 5.7, 40.0% of Civil and Building engineering students and 38.9% of Aeronautical and Automotive engineering students agreed that nobody encouraged them to study engineering, compared to only 20.8% of Design and Technology students and 20.0% of Electronic and Electrical engineering students.

The statistical test, the Tukey HSD, showed that there was a significant difference between Aeronautical and Automotive engineering and Electronic and Electrical engineering ($p<0.05$) and between Electronic and Electrical engineering and Mechanical and Manufacturing engineering ($p<0.05$). These findings indicate that if more women (and men) are to be attracted into the engineering professions, then much more needs to be done to raise awareness of the sector and access to good information.

5.2.3 Insight courses

One approach that appears to have been reasonably successful in raising awareness about engineering is to provide students with an opportunity to actually experience engineering, often through 'Insight'[4] or taster courses provided by engineering bodies:

> *I also did EMTA* [name of insight course] *engineering course for girls, which kind of confirmed that mechanical was the better one for me.*
>
> Erica, Mechanical & Manufacturing engineering student

> *At secondary school we were only ever told of mechanical and civil engineering, not of any other disciplines. By deciding to go to university and participating on an Insight course I discovered all the different disciplines that are available.*
>
> Open-ended response from questionnaire, woman

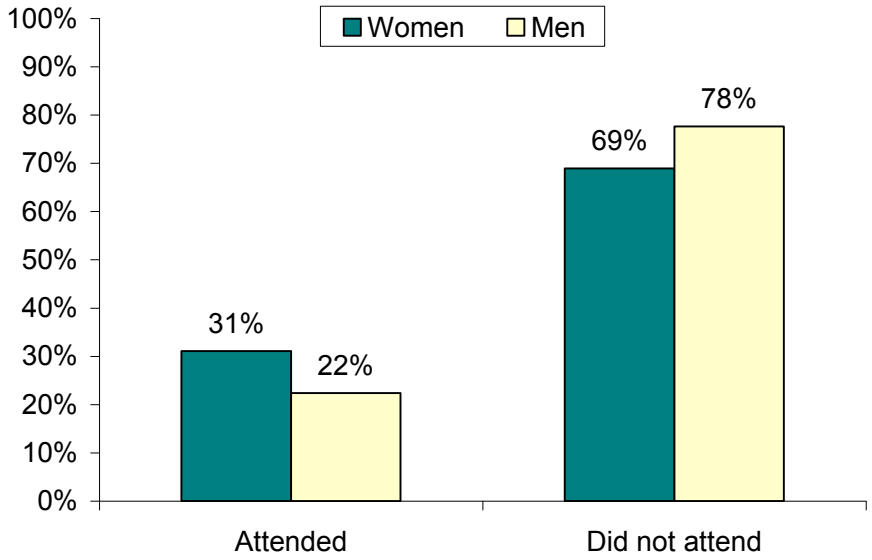
> *I believe that attending engineering Insight courses had a strong influence on my decision to study engineering at university (especially those that encourage females).*
>
> Open-ended response from questionnaire, woman

As shown in figure 5.8, the questionnaire found that almost a quarter (24.3%) of respondents, men and women, had been on Insight courses, and that, of these, 89.7%

[4] The Headstart programme is one example of an Insight course designed to encourage students interested in mathematics or science to consider technology-based careers (www.headstartcourses.org.uk)

agreed the course had encouraged them to study engineering at university. Women students (31.1%) were significantly more likely to have attended an Insight course than men students (22.4%) (t=-2.172; df 639; p<0.05).

Figure 5.8 Proportion of students that attended an engineering insight course, by gender



This shows how successful positive action measures can be in raising awareness of the engineering professions.

5.3 Skills, ability and attributes

This section explains students' references to their ability in particular subjects, skills in certain areas (particularly an aptitude for practical work) and characteristics or attributes that students' believed led them towards or made them suitable for a career in engineering.

5.3.1 Subject ability

Women engineering students' were frequently found to explain that the subjects they had studied at school (usually mathematics and physics, but also design and technology) influenced their decision to study engineering at university. Students' interest and ability in these school-subjects led them to consider engineering as a university option, as most engineering courses have substantial mathematics and physics components. Engineering therefore provided an opportunity to combine their skills and interest in both maths and physics.

I was doing maths and physics at 'A' level, and I was trying to find a degree that would have substantial proportions of that in it.

Eve, Civil & Building engineering student

I just found that I had a knack for maths and physics, so I thought engineering would be great to do.

Emily, Aeronautical & Automotive engineering student

I don't really know what it was that made me actually do engineering. I think my grades sort of geared me towards doing those 'A' levels, and then having chosen them it seemed the logical step. I knew I didn't want to do maths as a degree subject, I thought it narrowed it down a bit too much. Engineering was quite broad and sort of where my strengths lie, so that was why I chose the subject.

Sophie, Mechanical & Manufacturing engineering student

I don't know, I guess it started at school. DT [design and technology] *was always my best subject and I was always more interested so I just geared all my A levels around it.*

Matthew, Design & Technology student

In school I liked maths, science, 'the usual', so it just seemed a logical choice just to go into engineering.

David, Mechanical & Manufacturing engineering student

I sort of fell into it to be honest, because I applied for industrial design, but I didn't make the grades at 'A' level. Product design was my second choice because it's quite similar but more engineering based. So that's how I got into it, it's my second choice. But I'm glad I ended up on this.

Scott, Mechanical & Manufacturing engineering student

As the quotes indicate, this was an important factor for women and men students, although one student did suggest that ability may be a more important issue for women than men:

The women that go into it, are very good at it. You know whereas men just drift into it.

Andrea, Civil & Building engineering student

In addition it was also clear that engineering appealed to students because they did not want to specialise in either mathematics or physics.

The subjects that I chose at 'A' level all pointed to the same thing … they were Chemistry, Maths and Physics and Technology. I didn't want to specialise but they were all encompassed by engineering. So it was quite an easy choice for me.

James, Aeronautical & Automotive engineering student

It was sort of the only one that would incorporate all 3 of my 'A' levels, and I didn't want to drop any one in particular, so it seemed liked the best option.

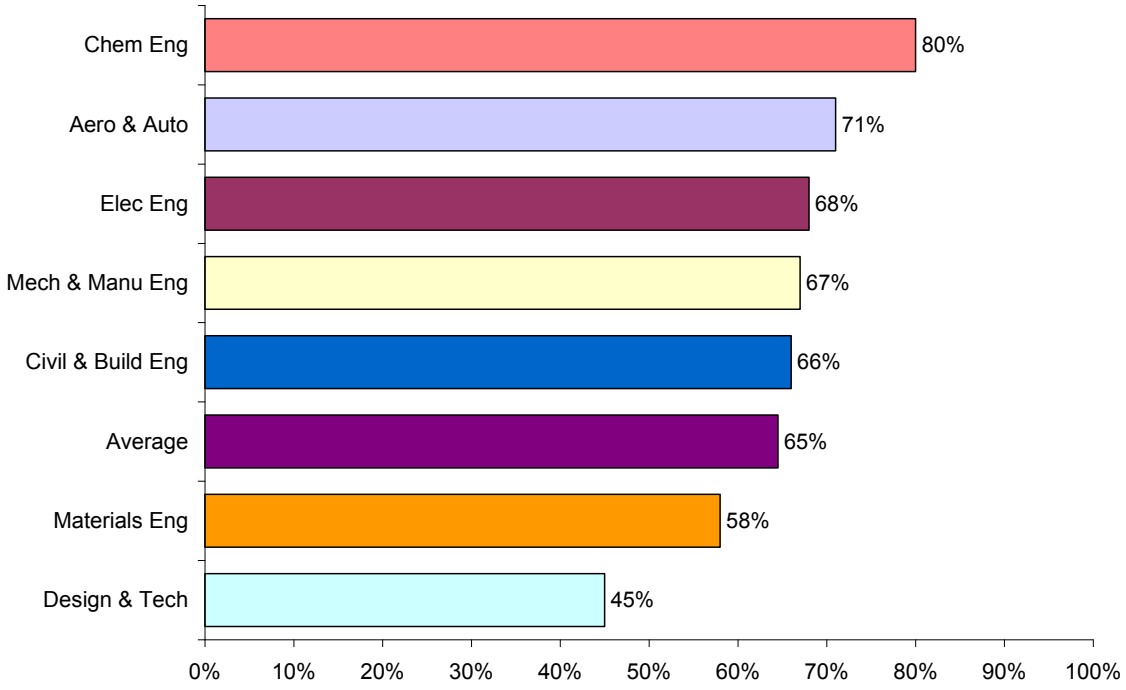
Amy, Mechanical & Manufacturing engineering student

This also links to the varied career prospects which engineering can provide and is discussed further in the career rewards section below.

These qualitative findings were also supported by the questionnaire which showed that over half of respondents (64.5%) agreed or strongly agreed that they wanted to use their science and maths background without specialising in either. However there was no significant difference in this variable by gender.

An independent one way ANOVA showed that the department students belong to has a significant effect on whether they wanted to use their science and maths background without specialising in either ($F=11.13$, $df=6, 643$, $p<0.01$). 79.5% of Chemical engineering students agreed with this statement, compared to only 44.6% of Design and Technology students, as shown in figure 5.9.

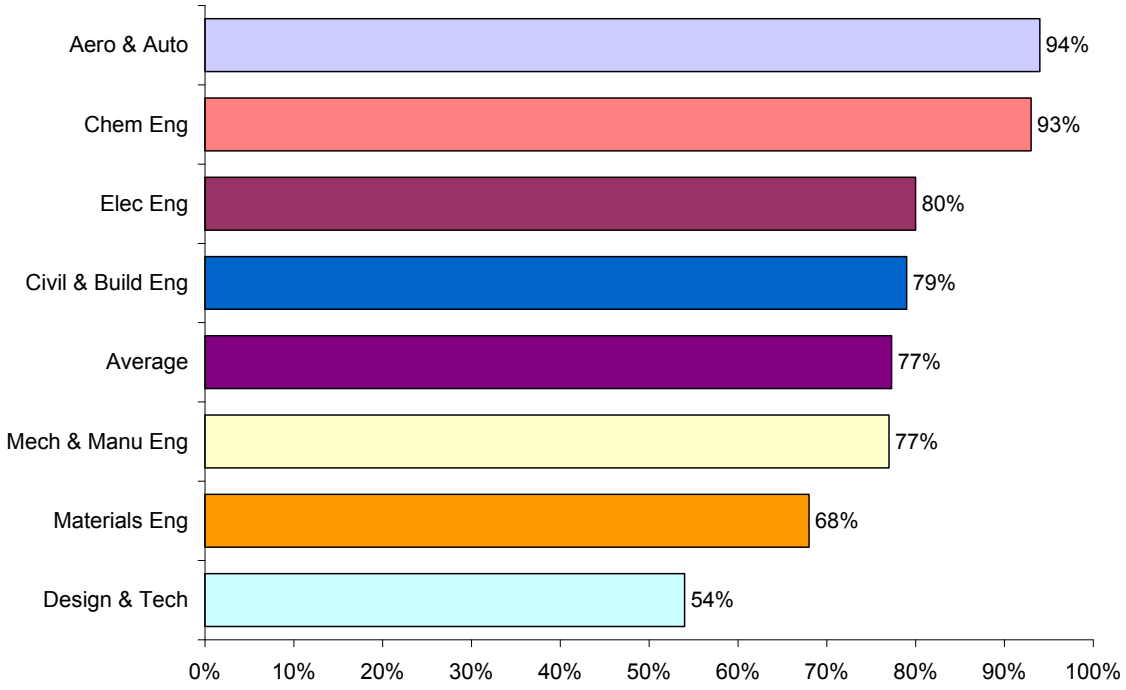
Figure 5.9 Proportion of students who agree that they wanted to use their science and maths background without specialising in either, by department



The Tukey HSD showed that there was a significant difference between Design and Technology and all other departments ($p<0.05$). Design and Technology students were less likely than other students (average $M=3.71$, $SD=0.98$) to agree that they were attracted to their course because they wanted to use their maths and science background without specialising in either.

However, 77.3% of students agreed that they were good at maths and science at school, with no significant difference by gender. An independent one way ANOVA did, however, show that the department students belong to has a significant impact on whether students believed they were good at maths and science at school ($F=10.96$, $df=6, 640$, $p<0.01$). As shown in figure 5.10, 94.4% of Aeronautical and Automotive engineering students and 93.2% of Chemical engineering students agreed that they were good at maths and science at school, compared to only 54.0% of Design and Technology students.

Figure 5.10 Proportion of students who agree that they were good at maths and science at school, by department



Employing the Tukey HSD, there was a significant difference between Aeronautical and Automotive engineering and Materials Science ($p<0.05$), between Aeronautical and Automotive engineering and Design and Technology ($p<0.01$), between Chemical engineering and Materials Science ($p<0.01$), between Electronic and Electrical engineering and Design and Technology ($p<0.01$), between Civil and Building engineering and Design and Technology ($p<0.01$) and between Manufacturing engineering and Design and Technology ($p<0.01$). These discipline differences may be related to perceptions about how important science and mathematics are to the disciplines in question.

5.3.2 Practical skills

Students, particularly women, were also keen to highlight their aptitude for or interest in practical skills and problem solving as a precursor for studying engineering:

> *I always liked taking stuff apart and building things*
>
> Stacey, Aeronautical & Automotive engineering student

> *I felt that engineering would allow me to get out from behind a desk and perhaps try something a bit more practical.*

Isabella, Mechanical & Manufacturing engineering student

I think it's just the creativity,, you're not just stuck writing an essay … you get to do model making, you can go and do rendering, there's loads of things you can actually do.

Amanda, Design & Technology student

When you go into work you could be doing anything. It's all about problem solving ... it's quite hands on ... there's a lot of scope and it makes you think a lot and it stretches your brain.

Holly, Mechanical & Manufacturing engineering student

Within this there was clearly a sense that engineering was a diverse or dynamic career option which the women engineering students' perceived as fitting their requirements not to 'sit at a desk all day'.

5.3.3 Perceived gender differences

Despite similar women and men's similar reflections on the skills and aptitudes they have leading them towards a career in engineering, and women's interest in practical skills, it was very interesting to hear women's perceptions that men may be more oriented towards engineering than women because of innate differences.

It's bound to be [male dominated], isn't it, because of the way the brain works, I've seen programmes about it.

Lisa, Materials engineering student

I think the whole maths and physics thing is to do with the way your brain works. Males tend to be better at that kind of thing anyway. Obviously you get a couple of females who are really good at it as well, but I think it's the natural way of doing things.

Jenny, Aeronautical & Automotive engineering student

In this sense, some of the women seemed to be distinguishing themselves from other women, as exceptions to the norm, since it was clear to them that there were particular 'natural' differences between men and women.

5.4 Career rewards

This section addresses some of the rewards and benefits students' perceived about pursuing a career in engineering, including the career prospects, salary and, for women students, perceptions about employability.

5.4.1 Career prospects

A number of students, especially those studying Aeronautical engineering or with an interest in the RAF, identified their long-term career ambitions as motivation for studying engineering. This seemed relevant to women and men:

> *I wanted to join the air force …* [but] *I was too short and I thought well if you can't fly them, why not learn how they work and how to design them … and it ended up carrying on from that really.*
>
> Emma, Mechanical & Manufacturing engineering student

> *My main ambition is to be an airline pilot and obviously to do that they look at maths and physics quite heavily so …*
>
> Jenny, Aeronautical & Automotive engineering student

> *I decided I wanted to be an airline pilot, but then after the terrorist attack on September 11th a lot of the airlines couldn't afford to take on any pilots that didn't have licences already. It costs a lot of money for them to fund a pilot to be trained … I couldn't go straight from 'A' levels to pilot training, so I decided to go to university and do something to do with aeroplanes.*
>
> Tracey, Aeronautical & Automotive engineering student

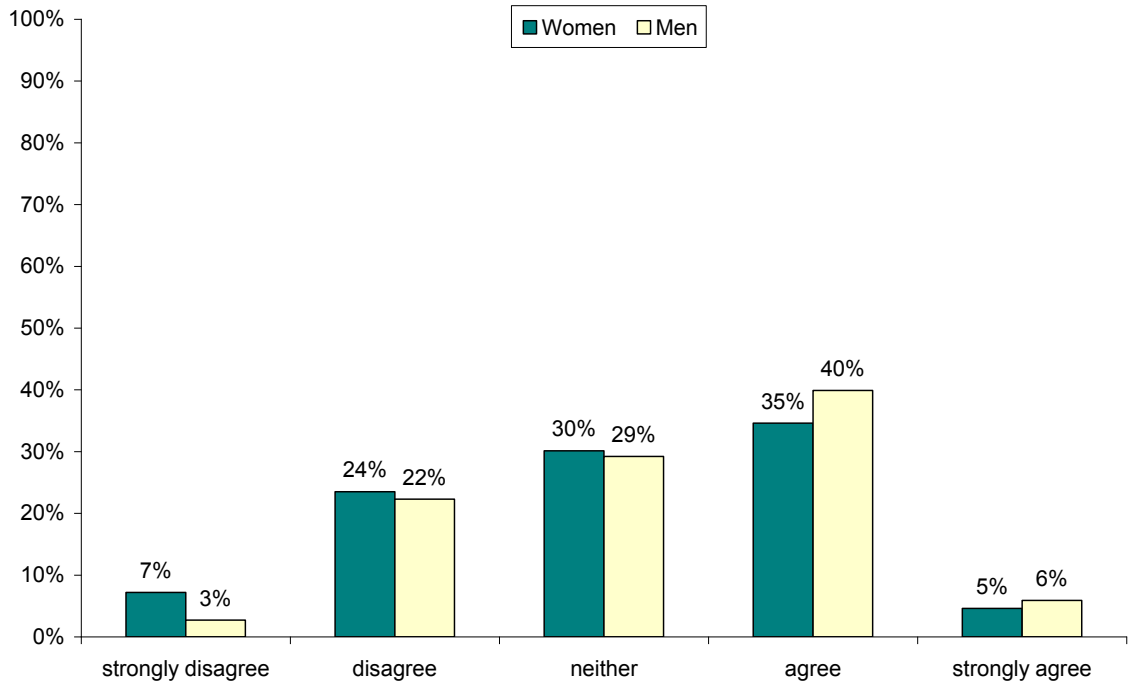
> *When I was at secondary school I went for a bursary with the RAF. I tried to be a pilot, but at the end of it they turned round and said I was colour blind so they wouldn't let me fly with them or get in the plane at all. They said, however you can do engineering. And I'd already chosen physics and maths … so I just carried on down that sort of route.*
>
> Peter, Aeronautical & Automotive engineering student

However, the number of students who appeared to have considered their career ambitions beyond university was limited, although a larger number perceived that studying engineering would enable them to keep their career options open. This is discussed further below.

5.4.2 Salary

The questionnaire indicated that 26.5% of students disagreed that they were attracted to a career in engineering because of the high salary. 43.9% of students agreed that they were attracted to engineering because of the high salary. The mean score for men attracted to engineering because of the high salary (M=3.24, SD=0.95) is significantly higher (t=2.03, df=640, p<0.05) than that for women attracted to engineering because of the high salary.

Figure 5.11 Proportion of students who agree they were attracted to engineering by the high salary, by gender

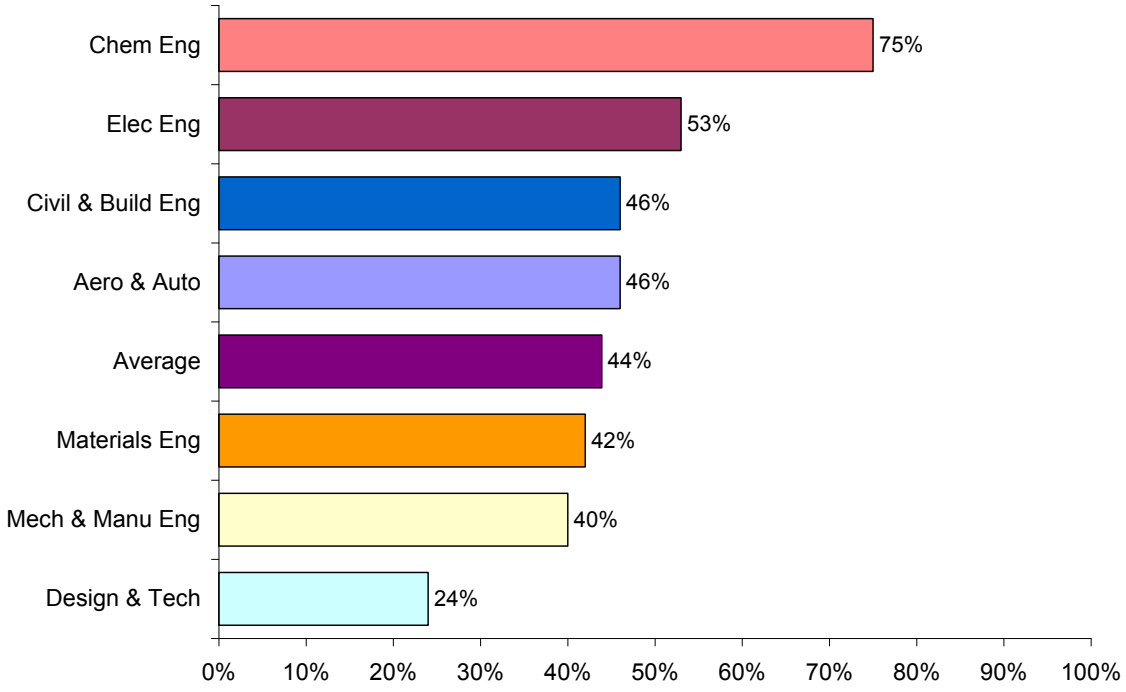


As shown in figure 5.11, only 39.2% of women students agreed or strongly agreed that they were attracted to engineering by the high salary, compared to 45.8% of men.

An independent one-way ANOVA showed that the department students belong to has a significant effect on whether students were attracted to engineering because of the high salary (F=8.75, df=642, p<0.01). 75.0% of Chemical engineering students agreed they

were attracted to engineering by the high salary, compared to 23.8% of Design and Technology students.

Figure 5.12 Proportion of students who agree they were attracted to engineering by the high salary, by department



Applying the Tukey HSD test, these was a significant difference between Aeronautical and Automotive engineering department and Chemical engineering ($p<0.01$), between Aeronautical and Automotive engineering and Design and Technology ($p<0.05$), between Chemical engineering and Mechanical and Manufacturing engineering ($p<0.01$), between Chemical engineering and Design and Technology ($p<0.01$), between Civil and Building engineering and Design and Technology ($p<0.01$), between Electronic and Electrical engineering ($p<0.01$) and between Mechanical and Manufacturing engineering and Design and Technology ($p<0.01$).

The interview data found mixed results in terms of students' attitudes to salary, with one woman stating that money was not the most important factor and another stating that the option she had chosen within engineering was effected by the potential to earn a good salary:

> *Ideal career? I don't know, just enjoy what I do, not do it for the sake of money. Of course money's important but I would like a job that I really enjoy not just because I need money.*

Jill, Civil & Building engineering student

I wanted to do something that was construction related but also had the potential to earn a fair bit of money and due to the lack of Quantity Surveyors it's a good field to be in at the moment.

Ben, Civil & Building engineering student

5.4.3 Employability

Interestingly, many women perceived that being a woman in engineering might increase their employability:

I thought that actually it might play in my favour, because applying as a girl, they're trying to get girls in engineering, therefore, if on paper me and another candidate were exactly equal, the fact that I was a girl would then, perhaps, I don't know, go in my favour and help me get on

Eve, Civil & Building engineering student

There seems to be sort of pressure on companies to not discriminate against people because of their age, or their sex or their race, so I think being a girl, I reckon nowadays if a company was faced with a girl and a guy with equal ability, they'd choose the girl. So that could be an advantage that … I think we might find it easier to get where we want, than the guys.

Tracey, Aeronautical & Automotive engineering student

I think another good advantage is in industry they've got to employ a certain percentage of women … I know that merely because I'm a women I've got a better chance than Joe Bloggs next to me who has exactly the same qualifications, simply because they've got to employ a certain percentage of women. So you know, it's not really anything to do with me being better than him, it's just that I'm a woman. But I don't think they'd employ me if they didn't think I was up to the job.

Jenny, Aeronautical & Automotive engineering student

I would be lying if I said I hadn't thought, I'm a girl and therefore I'll get a job.

Samantha, Civil & Building engineering student

You can play the gender card a lot ... there's more chance of a female getting a job than a male, which is kind of good.

Stacy, Aeronautical & Automotive engineering student

This was largely based on the belief that employers want to be perceived as diverse. It may have also been related to women's experiences of being recruited onto their engineering course:

They were desperate to get me on the course because they needed to balance out their numbers.

Rebecca, Design & Technology student

One guy … said you are bound to get [a bursary] *because at the end of the day they really need girls in engineering. And it really, really upset me.*

Sophie, Mechanical & Manufacturing engineering student

Whilst a drive to recruit more women into the industry is a positive step, it is clear that this had a knock-on effect of making women doubt their own abilities. Two of the interviewees quoted above, went on to say:

I've always felt like I don't know if I would have got on this course if I'd been a bloke … They didn't even look at my work, so they couldn't have known, and every bloke I've spoken to has had a really vigorous interview.

Rebecca, Design & Technology student

But then you think hang on, 'have I got this job just because I'm female or have I got it for my abilities?', but hopefully it's just for the ability.

Stacy, Aeronautical & Automotive engineering student

It may have also led women to believe, possibly falsely, that engineering workplaces would be equitable to women, posing the question of whether 'getting in' is the same as 'getting on' in engineering industries.

5.5 Identity

This section is concerned with how students' career choices related to their own identities. A key issue for women students appeared to be wanting to be different or relishing the challenge of working in a male-dominated industry, particularly if they had previous experiences of people suggesting that engineering is a career for men:

> *I get on well with men, rather than girls, and it's sort of a challenge being in a male dominated industry. I get a bit of a kick.*
>
> Debra, Design & Technology student

> *I really wanted to do something different. I'm the only one doing this course and everyone is like 'why?' That's something new isn't it? So really, I like to be different, and I'm not fussed about working with male colleagues and stuff like that.*
>
> Melanie, Civil & Building engineering student

> *At secondary school, they were all kind of well, 'girls can't build things'. I thought well, I'm gonna show them.*
>
> Stacey, Aeronautical & Automotive engineering student

> *I think I did it partly because no one else was really doing it at the time.*
>
> Chloe, Mechanical & Manufacturing engineering student

In making these statements the women also seemed to distinguish themselves as having more in common with men than with other women:

> *I'm quite a laddish girl. I don't think, if you're a bit kind of wet, you know, I don't think a girl would go far.*
>
> Debra, Design & Technology student

> *People doing civil engineering, they're very determined. They're very determined in terms of where they want to end up being, like a few years or really what they want to do ... quite strong minded and I think more ambitious as well. For myself, from my point of view, I think women engineers they are generally quite aggressive in term of what they want to achieve in their life, you know and, well, ambitious.*

Jill, Civil & Building engineering student

> *I do see a difference between girls in engineering and girls in other careers. It wouldn't be for everybody. I'd say for most of the girls I met in engineering they are more energetic, they have stronger personalities. It seems like they always have a plan, that we'll do this and this and this and in case that goes wrong we'll do plan B and plan B2 and so on. It could be the same for girls in other careers but from what I saw it's not as visible.*

Michelle, Civil & Building engineering student

A small number of women also perceived the engineering sector to be significant in terms of its impact or contribution to society:

> *I mean it's one of those things, if the world ended and there were only a few people left and you have a lawyer, a businessman and an accountant and an engineer, who would be the most useful? It'd be an engineer, of course it would be and that's always been* [my aim] *to do something, to make a difference in a way.*

Isabella, Mechanical & Manufacturing engineering student

5.6 Choosing a degree course not a career

While many of the findings above relate to factors contributing to students' career choice, it became clear that in choosing to study engineering, not all students had necessarily decided to pursue a career in engineering. Many students perceived that an engineering education and qualification would be a good foundation for a variety of career paths, not only in the engineering sector. This was true for both women and men:

> *I knew that having an engineering degree wouldn't, didn't just lead you to doing engineering. I knew that if I came out with an engineering degree, I could go off and do all sorts of stuff ... getting a degree was more important than the necessary career afterwards.*

Eve, Civil & Building engineering student

I think that what persuaded me, 'cos first of all I was debating between accountancy and engineering, but I think what swayed me, is that engineering is such a good basis for anything afterwards.

Stacy, Aeronautical & Automotive engineering student

Once you've got an engineering degree, you don't have to be an engineer, so I'm keeping it open.

Alison, Mechanical & Manufacturing engineering student

It kind of opens doors I suppose, to other things. You can't go into management, then into engineering, but you can do it the other way round.

Emma, Mechanical & Manufacturing engineering student

Mechanical [engineering]*, you can go into anything that you want to do. If you want to become a chemical engineer you can become a chemical engineer, or automotive or anything else.*

Isabella, Mechanical & Manufacturing engineering student

I think with mechanical engineering really you can go and do anything. They wouldn't question you if you went into automotive industry or into aerospace, if you're a mechanical engineer. That's just the way it is. But if you did aerospace engineering and then you wanted to go into the automotive industry maintenance [it would be much harder] *… so that was the logic behind this.*

Steven, Mechanical & Manufacturing engineering student

One of the reasons why I chose engineering was … I was always under the impression with an engineering degree you've got something to fall back on.

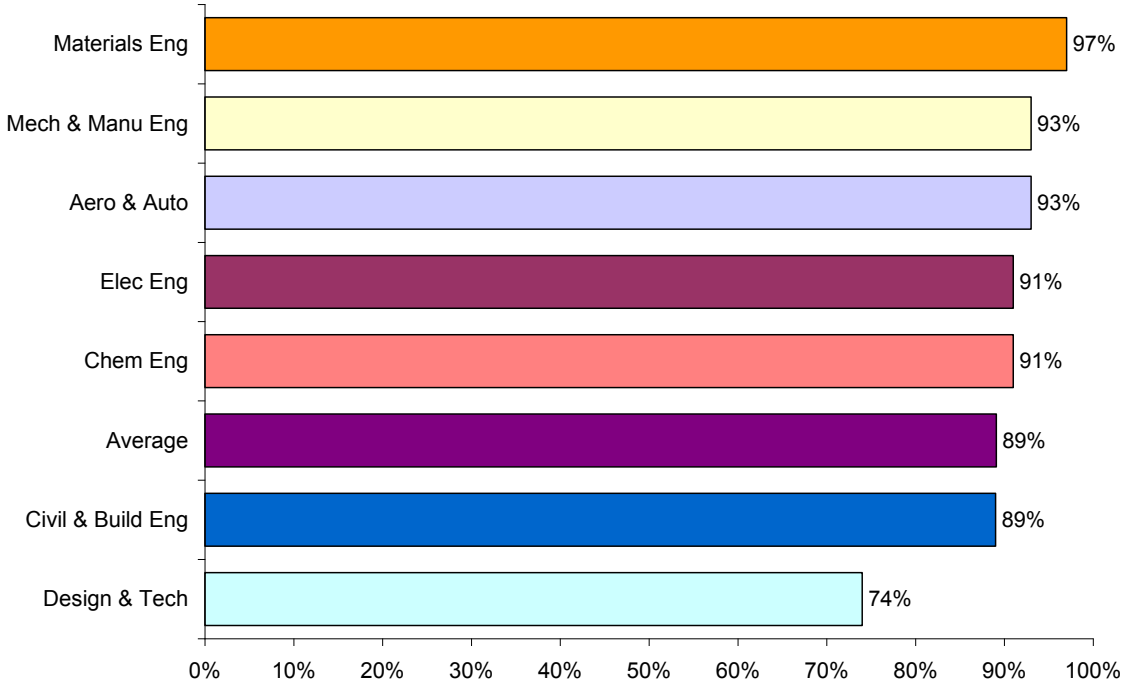
Richard, Mechanical & Manufacturing engineering student

I think it was made very clear to me that I don't have to do engineering.

Jackie, Mechanical & Manufacturing engineering student

The idea of engineering career prospects was also supported by the questionnaire, which indicated that 89.1% of students believe that engineering would be a good degree to have even if they decided not to enter the profession. There was no significant difference by gender. An independent one-way ANOVA showed that the department students belong to has a significant effect on whether they believe engineering will be a good degree to have even if they decide not to enter the profession ($F=9.33$, $df=6, 644$, $p<0.01$). As shown in figure 5.13, in most departments students had a fairly similar level of agreement about the fact that engineering would be a good degree to have. The exception to this was Design and Technology, where only 73.5% of students agreed with this statement.

Figure 5.13 Proportion of students who agree that engineering will be a good degree to have even if they decide not to enter the profession, by department



A Tukey HSD test showed that this difference between Design and Technology and all other departments was significant ($p<0.01$). Students from Design and Technology were less likely to agree that their degree would be valuable if they chose not to enter the profession ($M=3.77$, $SD=0.93$) compared to other students ($M=4.24$, $SD=0.76$). This suggests that some disciplines are seen as more interdisciplinary and offer a more generic education than other disciplines.

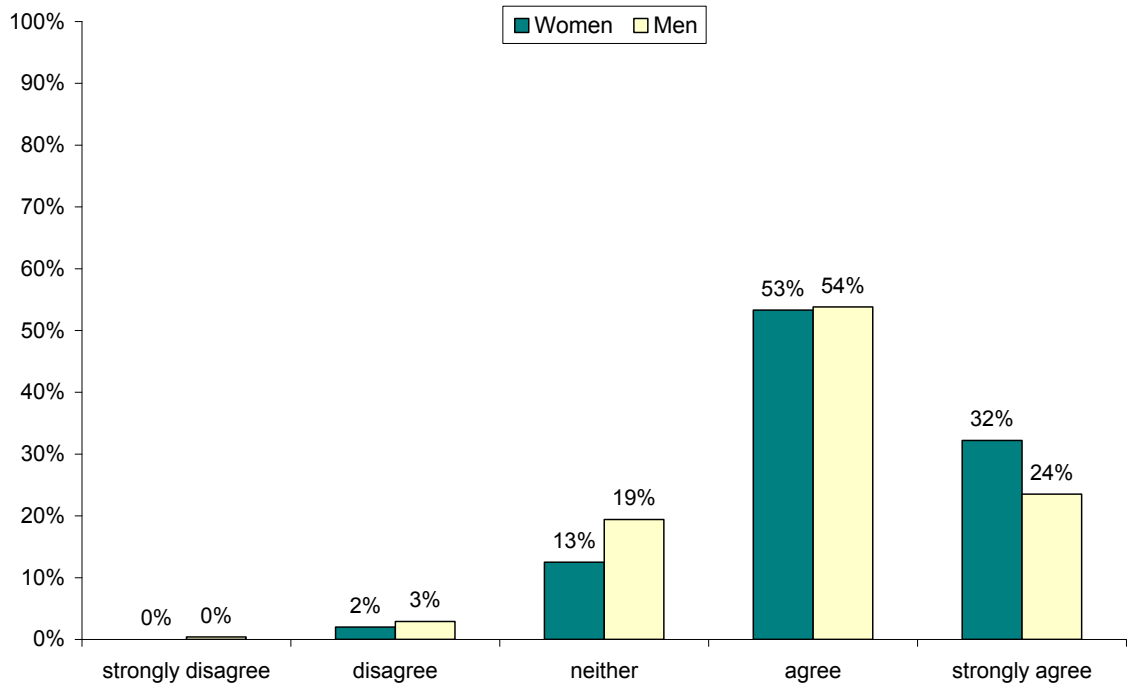
Career prospects are also related to students' school subjects influencing career choices, since engineering was chosen as a varied course, fulfilling more interests than a subject-specific course, such as mathematics or physics. Students therefore identified

engineering as interesting because of its varied nature, which is the same reason students' appeared to value it as providing varied career prospects and opportunities:

> *I think it's a bit diverse. Again, you can come into whatever discipline you choose afterwards.*
>
> Emma, Mechanical & Manufacturing engineering student

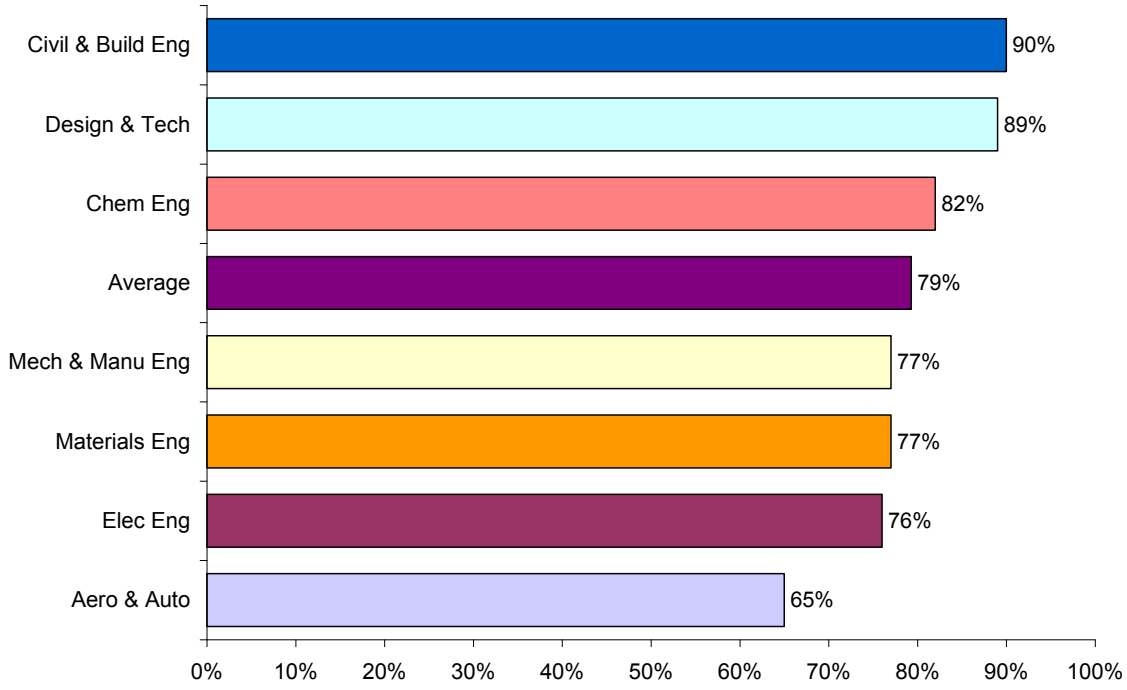
The questionnaire also showed that 79.3% of students found engineering appealing because it is so varied. An independent samples t-test showed that there was a significant difference between men and women views on this ($t=2.68$, $df=639$, $p<0.01$). Women students were more likely to be attracted to engineering because it is so varied ($M=4.16$, $SD=0.71$) than men ($M=3.97$, $SD=0.76$). In total, 85.5% of women agreed or strongly agreed with this statement compared to 77.3% of men (see figure 5.14).

Figure 5.14 Proportion of students who agree that engineering appeals to them because it is so varied, by gender



An independent one-way ANOVA showed that the department students belong to has a significant effect on whether engineering appealed to them because it is so varied ($F=3.48$, $df=6, 641$, $p<0.01$). As shown in figure 5.15, 89.6% of Civil and Building engineering students and 89.2% of Design and Technology students agreed that engineering appealed to them because it is so varied, compared to only 65.2% of Aeronautical and Automotive engineering students.

Figure 5.15 Proportion of students who agree that engineering appeals to them because it is so varied, by department



Employing the Tukey HSD, there was a significant difference between Aeronautical and Automotive engineering and Civil and Building engineering ($p<0.05$) and between Aeronautical and Automotive engineering and Design and Technology ($p<0.01$).

5.7 Perceived barriers to engineering for women

Students were also asked about why they thought that women were not more represented in engineering. Women's responses to this generally indicated that they thought engineering was equally available as a career choice to both women and men, despite some of the contradictory evidence to this which has already been presented.

> *If women wanted to do it they would easily be able to. As I said, any girl can get onto my course and so if they wanted to they would be here. It is just that it just doesn't attract interest, I don't think.*
>
> Rebecca, Design & Technology student

> *I think it's pointless encouraging girls to go into engineering if you know, they're just not interested in it.*
>
> Jenny, Aeronautical & Automotive engineering student

I think the ones [women] *that want to* [engineering] *do it, and the ones that don't do it, just don't want to. It's not like it's not advertised enough. I just think that's the way it goes: a lot of girls like to do languages and things like that and a lot of boys want to take cars to bits and put them together. I know it sounds sexist but I think I don't think that'll ever change unless girls do engineering and I think the ones that do want to, do it. I don't think they choose something else because of fear of the boys or something. Every woman has got the opportunity to do it, and if they still don't want to then it must just be what it involves. It puts people off. If they've got the opportunity and I think engineering is encouraged just as much as medicine and law. I don't think it's considered that professional. I think that might be what it is. Like a doctor's considered professional and lawyers and stuff but I don't think engineering's got that kind of clean cut professionalism linked to it, so women don't think that they want to be involved with it. I don't know why.*

Tracey, Aeronautical & Automotive engineering student

Implicit in the descriptions above, is the idea that only 'certain types' of women choose to study engineering. This was reinforced elsewhere, where the women engineering students revealed very stereotypical views of women, and a belief in fundamental differences between men and women:

Although there are some women out there who you know, want to go and play in the mud and enjoy surveying all day long and all the rest of it, most women don't and that's because of fundamental differences between men and women.

Andrea, Civil & Building engineering student

I think engineering is one of those things that, you know, a bloke is often better at the job because of the way men think about problems and the way women think about problems. And, the way men think about it is more of an engineering way as it were so I think women should be encouraged to come into engineering and, you know, be encouraged to become professional engineers but if they can't think about the problem in the right way then it's just not going to happen.

Sarah, Chemical engineering student

In making these comments, the women engineering students seem to be at once highlighting the so-called 'fundamental' or 'natural' differences between men and women, but also dis-identifying themselves from their own gender, in making themselves an

exception to the general rule of difference. However, in some cases, it was argued that within engineering, women were likely to bring different skills, abilities and views to the table compared to men:

> *I know it sounds a bit clichéd when they say that girls can't think like guys, but it's really true. It's like there are certain things that I've found a lot more difficult than other people and there are certain things I'm a lot better at ... There's lots of things it might be, but I think something that I struggle with is thinking in a different way. Thinking out of the box, as they say.*
>
> Isabella, Mechanical & Manufacturing engineering student

There also seemed to be a suspicious attitude towards some of the other women engineering students:

> *Sometimes I think that the girls might be interested in doing the course because it's male-dominated. Girls who like love to be surrounded by blokes all the time ... people say to me like, 'oh my god, that sounds so cool', it's like one hundred and twenty blokes and ten girls or whatever. It doesn't really cross my mind but there are probably girls who are like that.*
>
> Rebecca, Design & Technology student

> *There's some girls I suppose who every boy they see is a potential boyfriend and I just see them as individual friends*
>
> Tracey, Aeronautical & Automotive engineering student

Possibly as a result of these stereotypical and critical attitudes, the women also seemed reluctant to see more women participating in engineering:

> *We're a novelty right now you see.*
>
> Samantha, Civil & Building engineering student

> *Well* [if there were more women in engineering] *it could be competitive for me then, so no.*

Erica, Mechanical & Manufacturing engineering student

This was also combined with a concern that things had to be equal for men as well, possibly emphasising a belief in equality, but not feminism:

> *I mean I am up for women's rights and all that stuff, but if there are loads of blokes that want to go into it, well they should.*

Sophie, Mechanical & Manufacturing engineering student

5.8 Summary

- This chapter has explored the various factors influencing women engineering students' career choices.
- Some of the important factors include: socialisers, such as parents and teachers; knowledge of the engineering professions; skills, ability and attributes; career rewards, such as prospects, salary and employability; and, identity.
- It also shows that not all engineering students have chosen to pursue a career in engineering, but rather a degree programme that is perceived to be a good foundation for a variety of career options.
- It highlights some of the gendered differences in career choice and also some of the conflict or tensions that gender creates. For example, women engineering students show that they are attracted to engineering because it matches their aptitude and skills, but many also hold stereotypical views about the differences between men and women, which they believe make men better engineers than women.
- The analysis also reveals some key discipline differences, particularly between Design and Technology and other engineering disciplines. Some of these differences may be a result of the different entry requirements (e.g. whether or not Mathematics and Science A levels are necessary) of different subjects, although this does not explain apparent gender differences between the disciplines.
- Chapter six, *Women's Experiences of Higher Education,* moves away from career choices to examine women engineering students' experiences of HE, in particular their experiences and interpretations of their course experiences and relationships with other students and with staff.

6. Women's Experiences of Higher Education

This chapter of the thesis examines women engineering students' experiences of HE. It explores the nature of HE engineering cultures and whether these cultures vary by discipline. It builds on the previous chapter by investigating the relationship between these cultures and women engineering students' gendered and professional identities. As with chapter five, the analysis draws on data from both the qualitative and quantitative datasets, the findings of which are compared throughout the analysis.

The analysis of data revealed a number of key themes which have been categorised as course experiences, including perceptions regarding the relevance, difficulty, content and assessment of the course, and relationships with other students, other women engineering students and engineering staff. As with the previous chapter, it is important to note that the categories are not exclusive but intertwined and mutually reinforcing.

6.1 Course experiences

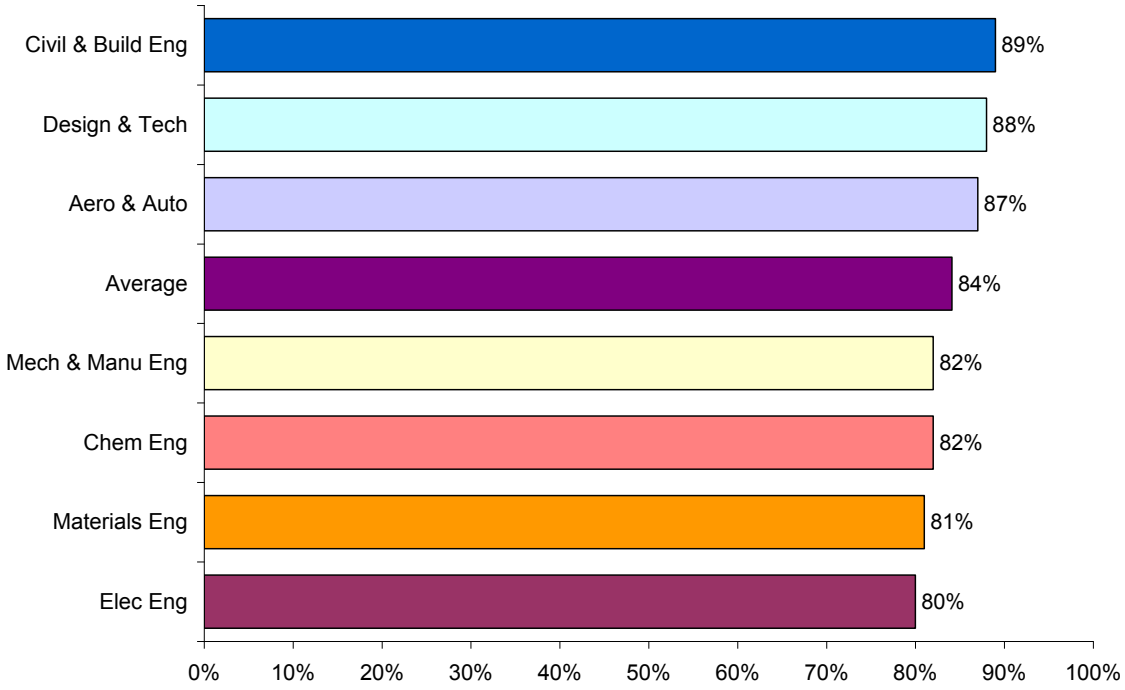
This section begins with some general information on students' views about their courses, before describing in more detail some of the specific concerns students had about the relevance, difficulty, content and assessment of their courses. Students, women and men, were, on the whole, positive about their courses and teaching:

> *The best things are that I do actually enjoy the work. Like you know, when I sit down to do it, it is something that I enjoy doing.*
>
> Amanda, Design & Technology student.

The questionnaire indicated that on average, 84% of respondents were pleased they chose to study engineering. A statistical independent samples t-test showed that there was no significant gender differences on this variable, although an independent one-way ANOVA showed that there is a significant relationship between department and students' agreement that they were pleased they chose to study engineering ($F=2.55$, $df=6$, $p<0.05$). As shown in figure 6.1, there was not much variance in students' levels of agreement between departments. However, the Tukey HSD statistical test showed that there was a significant difference between Mechanical and Manufacturing students and Design and Technology students ($p<0.05$). The differences between other departments may not be statistically significant because of the number of respondents in each

department and the proportion of students 'neither agreeing nor disagreeing' and 'disagreeing'.

Figure 6.1 Proportion of students who agree that they are pleased they chose to study engineering, by department



Similarly to the findings around career choice women students, in particular, favoured the diversity of engineering courses, often citing this as a reason for having chosen to study engineering over other courses:

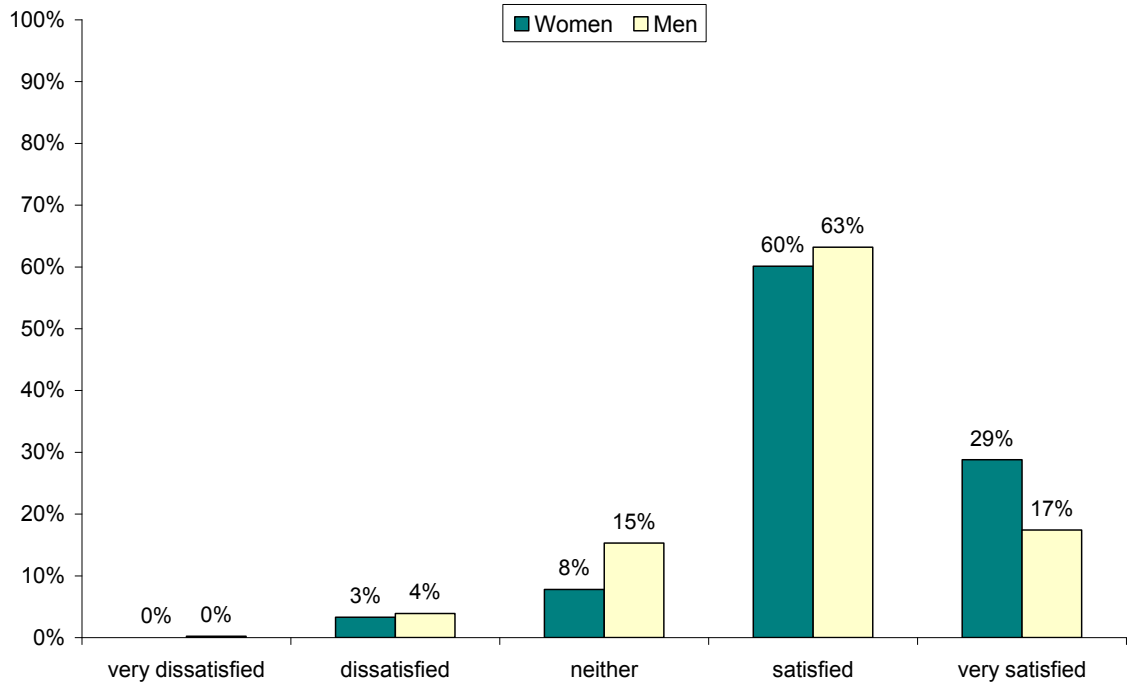
> *With aeronautical … I liked it because it was so broad, you learnt everything from you know, electrical to mechanical to, you know, say systems and programming.*
>
> Emily, Aeronautical & Automotive engineering student

> *The best thing is the breadth of my course really. And it's great that we get to do a bit of everything which really prepares us for industry I think.*
>
> Julie, Mechanical & Manufacturing engineering student

However, this also created something of a dilemma for students, whom, while valuing the diversity of their courses, often found it difficult to recognise the relevance of aspects of the course and criticised the volume and intensity of their work load, as will be demonstrated later.

However, the questionnaire showed that there was a significant difference in the proportion of men and women that were satisfied with the variety of subjects the course covers ($t=3.18$, $df=640$, $p<0.01$). Women students were more satisfied with the variety of subjects the course covers ($M=4.14$, $SD=0.69$) than men students ($M=3.94$, $SD=0.71$). As shown in figure 6.2, 88.9% of women students were satisfied or very satisfied with the variety of subjects their course covered, compared to 80.6% of men. However, this does not explain whether women would have preferred to see more or less variety than male students.

Figure 6.2 Proportion of students who are satisfied with the variety of subjects the course covers, by gender



As was suggested in the literature, students were found to be attracted to a curriculum that offered more than technical engineering:

> *When I tried to get into my course it was … the commercial management that attracted me. I think that if I don't do well in the engineering sector, I [can] do the commercial bit.*
>
> Anna, Civil & Building engineering student

This quote, however, also highlights women's lack of confidence in their ability at technically oriented subjects. It also supports the idea that although students have chosen a degree course, they may have yet to decide a career path.

6.1.1 Relevance

Despite favouring the varied nature of engineering courses, both women and men students often found it difficult to understand the relevance of some modules. This may have particularly been the case as many courses did not offer students the opportunity to choose their own modules:

> *Some of the work we do, you're like why? Why do I need to know this? Or, why are we learning it now? I think we could have spent more time on other stuff.*
>
> Hannah, Civil & Building engineering student

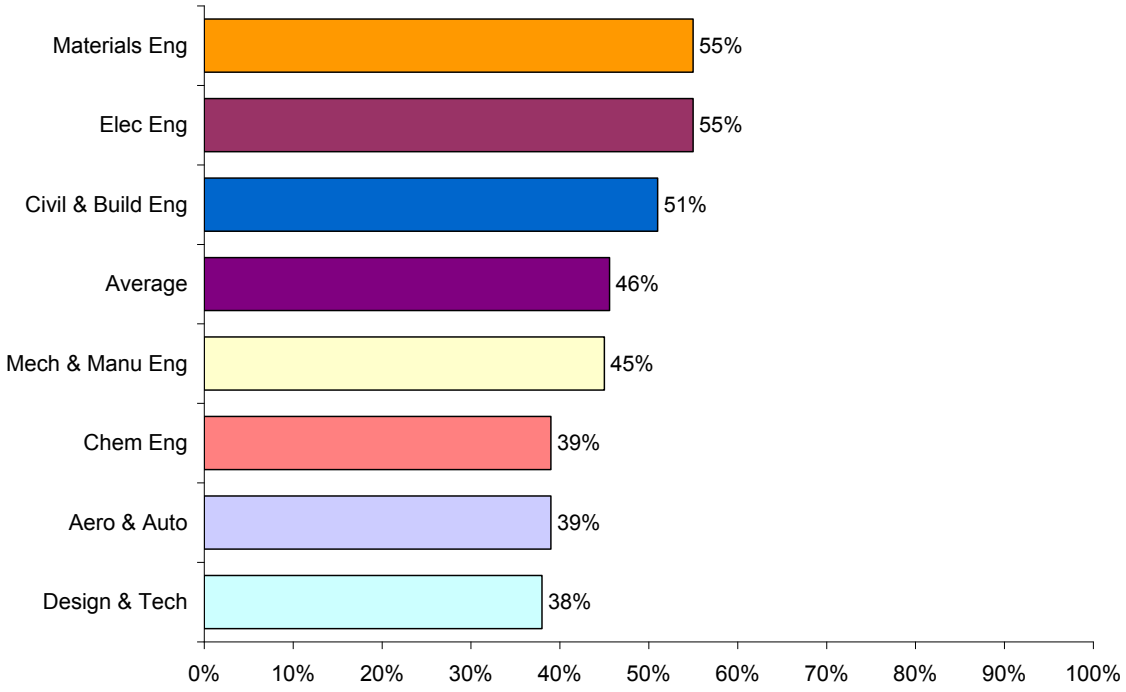
> *Sometimes … you think what the hell is going on here? When you're doing this crazy maths you think 'what does this apply to?' But you've just got to ask, 'what's this in real life?' and then they'll tell you.*
>
> Tracey, Aeronautical & Automotive engineering student

> *Obviously when you read prospectuses it highlights – it puts down the highlights of what you're going to do and doesn't tell you so much about the more boring modules and things, the long hours that engineers in particular, from what I've seen, have to put in.*
>
> Paul, Aeronautical & Automotive engineering student

> *Some things, although not that interesting, it's beneficial to a lot of people. Whereas there are certain things on the course that you think what percentage is going to benefit basically. And I think sometimes you've got to say, well, it doesn't benefit enough so surely it could be time spent better elsewhere.*
>
> James, Aeronautical & Automotive engineering student

The questionnaire also showed that students found it difficult to understand the relevance of some modules, with 48% of all respondents agreeing or strongly agreeing with this statement. However, no significant difference was found between men's and women's attitudes ($t = 1.315$; $df = 640$; $p>0.05$). Students in Materials engineering (54.8%) and Electronic and Electrical engineering (54.5%) were most likely to agree that it is difficult to understand the relevance of some modules (see figure 6.3), although a one-way ANOVA shows that there are no significant differences between engineering disciplines ($F = 1.977$; $df = 6, 642$; $p>0.05$).

Figure 6.3 Proportion of students who agree that it is difficult to understand the relevance of some modules, by department



There was also a perception among students that course content was dictated by the Professional Institutions, in order to obtain accreditation:

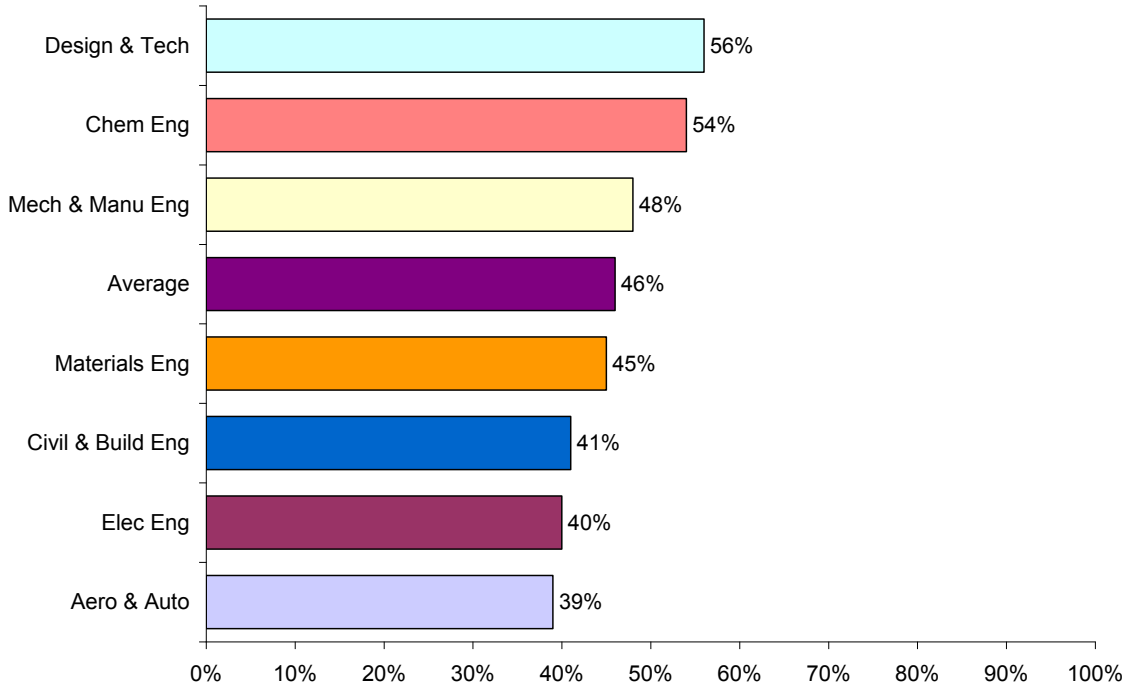
> *The thing is, if the ICE* [Institution of Civil Engineers] *say you've got to do this stuff you've got to do it because they're the guys that affiliate our course.*
>
> Samantha, Civil & Building engineering student

While this was historically the case, since 2004 accreditation has been based on output standards (published in UK-SPEC, ECUK 2004), rather than prescription and admission standards (Dickens and Arlett, 2009). The new accreditation approach shifts emphasis from 'what is being taught' to 'what is being learned' (Mills and Treagust, 2003).

6.1.2 Difficulty of course

As shown in figure 6.4, the questionnaire also indicated that on average 46.0% of students found the engineering curriculum more difficult than they expected, ranging from 39.3% of Aeronautical and Automotive engineering students to 56.4% of Design and Technology students. An independent one-way ANOVA showed that there is a significant relationship between department and agreement that the engineering curriculum is more difficult than expected ($F=3.81$, $df=6, 638$, $p<0.01$).

Figure 6.4 Proportion of students who agree that the engineering curriculum is more difficult than they expected, by department



Employing the Tukey HSD, there was a significant difference between Aeronautical and Automotive students and Design and Technology students ($p<0.05$) and between Electronic and Electrical students and Design and Technology students ($p<0.01$).

> *We have projects where we had to make prototypes, just models and stuff, and I found that quite difficult because I'd never done it before. Whereas the boys, they, even though they've not done as much, they seem to have a better understanding of how to do it.*
>
> Catherine, Design & Technology student

> *We do think very differently. I think probably lads are likely to have a lot more technical knowledge and so I'm having to work quite hard to keep up really. And then I think girls have a better approach in the fact that they probably do the paperwork and sometimes girls will do the research you need to do, within a project, whereas lads just dive in.*
>
> Natalie, Civil & Building engineering student

Again, in contrast to valuing the diversity of courses, students frequently raised the volume and intensity of engineering courses. While this was mentioned by numerous

students, it was particularly Design and Technology Students that referred to the volume of work they had:

> *It's been a lot more hours than I thought it'd be, it's like 24-7, just working. I've got lectures most of the day, and then I'm working at night to do the stuff that they've set us in our lectures.*
>
> Jessica, Design & Technology student

> *The worst things are the amount of work … we have a lot of deadlines in at the same time. You don't get much sleep at all. A lot of the work is very time consuming ... there's always an on-going project. But then, I suppose that's something I like anyway.*
>
> Elizabeth, Design & Technology student

> *The down side is just the work load really. We had like 25 hours a week last semester, which, when you think about when people work they're doing like 40 hour week, it isn't very much, but when you think about how much work you've got to do in your free time and how tough that work is and how varied it is and in every single module, it's really difficult, that's quite hard.*
>
> Jenny, Aeronautical & Automotive engineering student

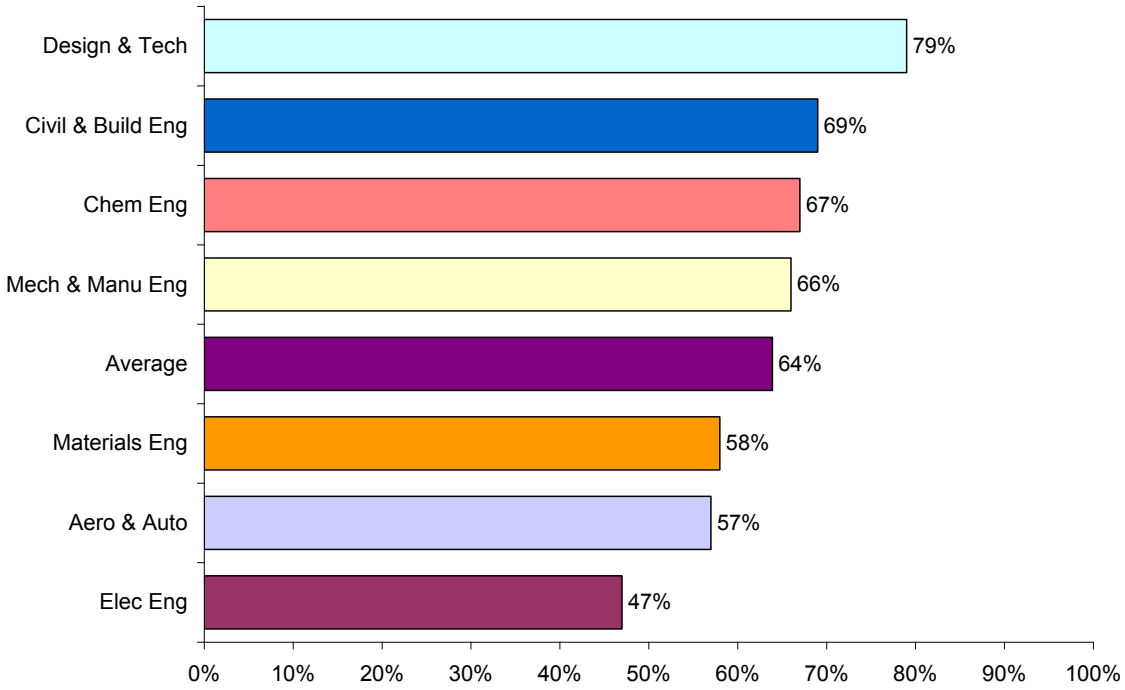
> *The worst thing has got to be the sheer volume of work at times, and the fact that you sort of start a week and finish a week without having actually seen daylight, because you're glued to your desk.*
>
> Andrea, Civil & Building engineering student

There remained a perception amongst many women engineering students that they worked harder than those in the social sciences, arts and humanities areas. Although data were not collected to explore the validity of this perception, some alluded to the additional efforts necessary to succeed in group work, which dominated coursework assessment within the engineering faculty.

Students also indicated that they often have competing deadlines. This was particularly clear in the questionnaire, which showed that, on average, 63.9% of students agreed that they always have competing deadlines, ranging from 79.4% of Design and Technology

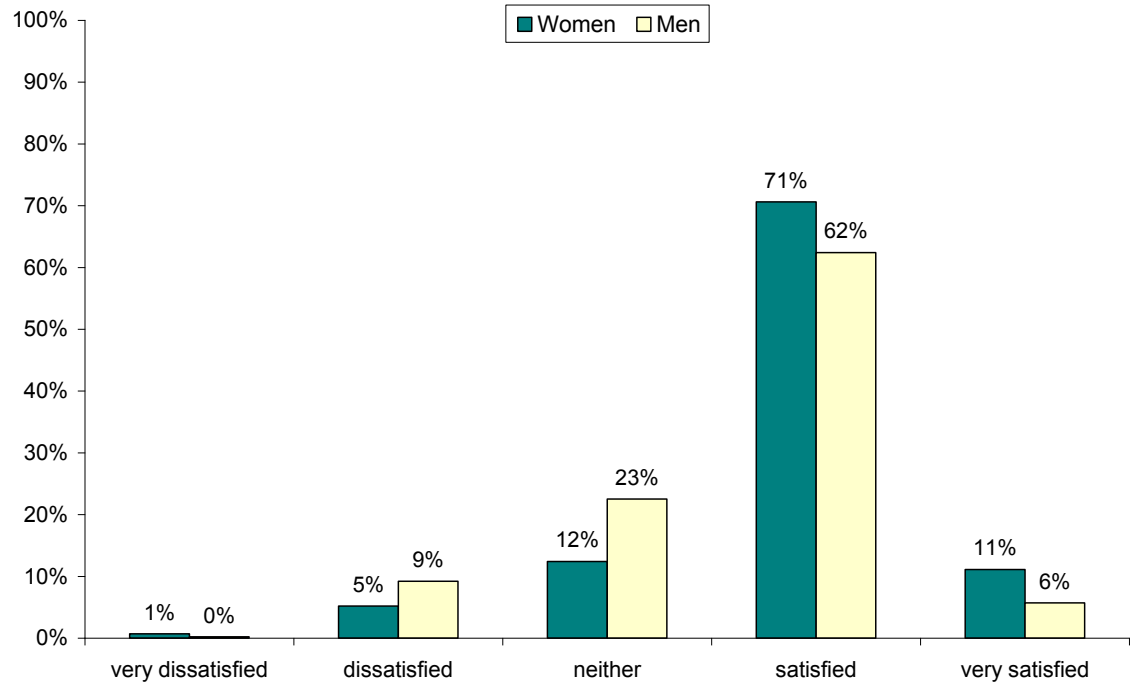
students to only 47.2% of Electronic and Electrical engineering students, as shown in figure 6.5. A one-way ANOVA showed that there is a significant relationship between departments and agreement that students always have competing deadlines ($F=4.80$, $df=6, 639$, $p<0.01$). A Tukey HSD test showed that there was a significant difference between Aeronautical and Automotive students and Design and Technology students ($p<0.01$), between Electronic and Electrical students and Design and Technology students ($p<0.01$) and between Electronic and Electrical students and Mechanical and Manufacturing students ($p<0.05$).

Figure 6.5 Proportion of students who agree that they always have competing deadlines, by department



The questionnaire also asked students whether they were satisfied with the number of teaching hours they received, 71.0% of students said they were satisfied. 81.7% of women were very satisfied or satisfied with teaching hours compared to 68.1% of men (as shown in figure 6.6). An independent samples t-test showed that the mean score for women satisfied with the number of teaching hours ($M=3.86$, $SD=0.89$) was significantly higher ($t=3.37$, $df=266$, $p<0.01$) than males who are satisfied ($M=3.64$, $SD=0.74$). The variances for males and women were significantly unequal ($F=13.76$, $p<0.05$), therefore a test for unequal variances was used.

Figure 6.6 Proportion of students satisfied with the number of teaching hours they received, by gender



6.1.3 Course content

Another aspect of learning methods is whether the content of courses is driven by theory or practical work. Most students recognised that theory was an essential part of the learning process, but also believed that practical, hands-on work could play a greater role in the course:

> *I expected it to be a bit more practical. The theory isn't too bad, but there's so much to take in and to understand. I'd personally like a bit more practical.*
>
> Chloe, Mechanical & Manufacturing engineering student

> *We haven't done as much kind of proper hands on stuff, like being in a lab and using a lathe … it wasn't really developing their skills, it was just giving them an insight and stuff. So I was expecting it to be more, like actual making stuff, which we haven't really done.*
>
> Holly, Mechanical & Manufacturing engineering student

> *I thought it would be a bit more design; a bit more contact with aeroplanes and a bit more lab work but … I know that they are really under funded and they can't afford to let us do a lot of practical work and run wind tunnel. I think there's a lot*

more theory than I expected ... but I can handle that. A lot of people have left because they can't do maths day in and day out, but they wanted to see like cars and planes and things but I'm OK with it, even though it wasn't what I expected, it's still not that different.

Tracey, Aeronautical & Automotive engineering student

I thought it was going to be more practical … there's definitely a lot more learning and sort of less actual hands-on than I thought there was going to be.

Hannah, Civil & Building engineering student

Disappointment with the lack of practical work may be related to career choice, in that many students chose to study engineering with the expectation that it would be more hands-on, practical and problem-solving than the other university options they had such as physics or mathematics.

Students were concerned that they were not gaining the experience necessary to be 'an engineer':

I went to the motor club the other week, to watch a couple of my friends taking out an engine. And, while I'm doing all these things about engines and systems, I couldn't tell you what these things were, and I think that probably affects what I can do, in terms of industry. Like, if you've got a part and it needs to be supervised, taken out or whatever, and you don't even know what it looks like, how it works, all you've got is a triangle on a piece of paper and the guys there, obviously knew, it'd probably be detrimental. So probably a bit more hands on, more examples, realistic examples.

Emma, Mechanical & Manufacturing engineering student

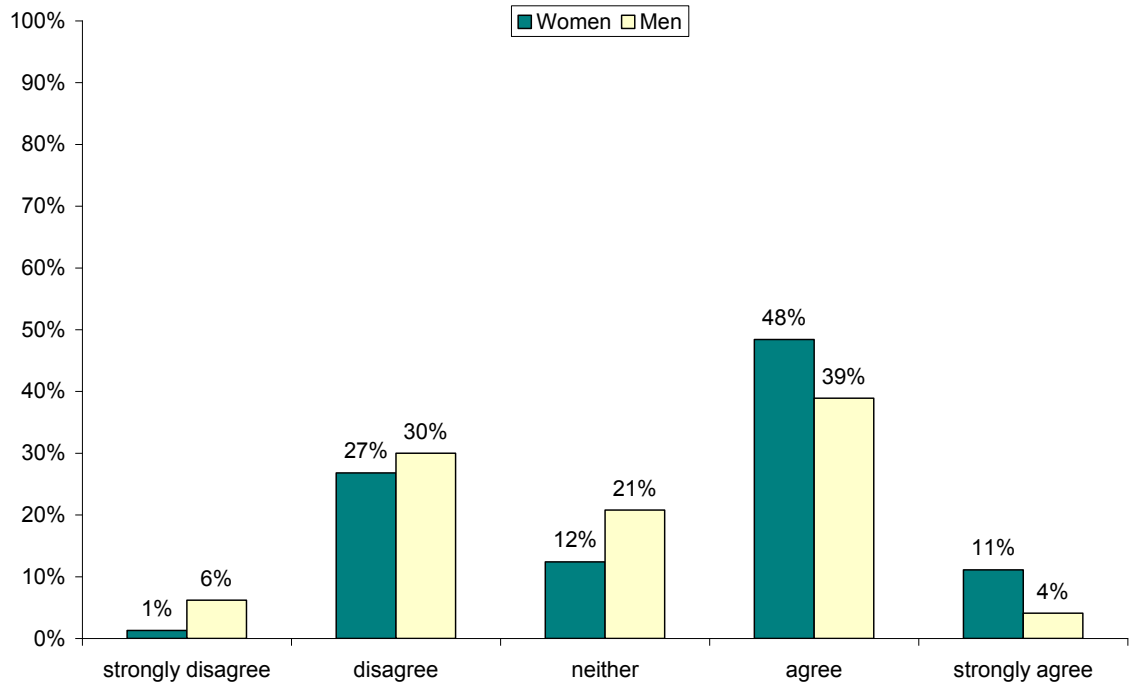
I find that now I am on site I lack the practical experience and theoretical knowledge that is needed to be a good site engineer. I found that most of my theoretical knowledge was not all that useful, as most of my job involves working on the ground works and having to set out and keep the workers happy. The problem is a lot of the theory we do does not cover actual building practices and how buildings actually get made. If the teaching course had more optional modules based on whether the student wanted to go into consulting or contract work I would be in a far better position to do my job now.

Open-ended response from questionnaire, man

Conversely, students who had experienced very practical modules such as surveying *'where you actually go out and learn how to use the instruments'* (Eve, Civil & Building engineering student), thought these lessons would be invaluable, particularly when they moved into industry. This suggests that some women engineering students were looking to immediately utilise vocational knowledge from their degree programmes that they could arguably acquire fairly rapidly upon embarking on their professional careers.

These results are in contrast to those from the questionnaire that indicate that 46.4% of students are happy with the level of practical work on their course. Moreover, as shown in figure 6.7, 59.5% of women believed the level of practical work on the course to be just right compared to 43.0% of male respondents. An independent samples t-test showed that this difference is statistically significant ($t = 3.75$; $df = 637$; $p<0.01$).

Figure 6.7 Proportion of students who agree that the level of practical work on the course is just right, by gender



Women students in the questionnaire may be satisfied with the level of practical work because it is an area they are not familiar with, whereas men students are more likely to be 'tinkerers' prior to starting university.

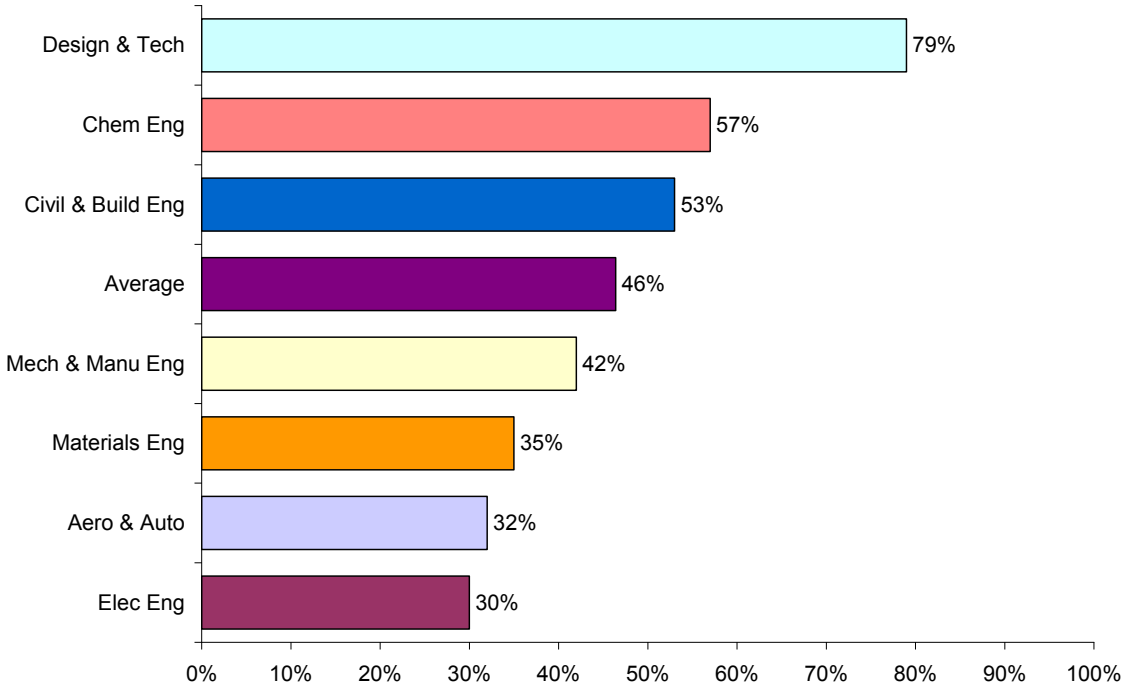
> *I thought that we would get more support than we do get as I never undertook any practical work or electronics or mechanics at college therefore I found these*

elements very difficult. I feel that the lecturers often take it for granted that we're all experts in the subject and most of them aren't very approachable.

Open-ended response from questionnaire, female

This does not however, mean that it is unimportant for women to undertake practical work, in fact, the experience it can provide them with may make it all the more significant. The Kruskal Wallis test also showed that there are significant departmental differences between students' views on the levels of practical work (X^2 =74.291; df = 6; p<0.01). As shown in figure 6.8, the department of Design and Technology had the greatest level of satisfaction with 79.0% of respondents agreeing that the level of practical work on the course is just right, while the lowest level of satisfaction was in Electronic and Electrical engineering (29.4%) and Aeronautical and Automotive engineering (32.2%).

Figure 6.8 Proportion of students who agree that the level of practical work on the course is just right, by department



6.1.4 Assessment methods

The majority of students interviewed also preferred coursework to exams:

I think that the people that are more practical are probably the people who don't do so well in exams. They are so theoretical … This semester we've only had like 20% [coursework] *for each module. So that's 80% exams. So if you do crap in the*

exams then it really buggers you up. I did ok on the coursework, I got like A's and B's, and I wish they'd been worth more really. I do enjoy the 100% coursework modules, because we had one last year. It was engineering design, it was group work but it was so good. We had to design this building and we did everything for it … it was really fun.

Samantha, Civil & Building engineering student

I think the best bit is having 50% course work, 50% exams, I think I'd rather do more course work than exams. I like that.

Melanie, Civil & Building engineering student

However coursework usually accounted for a very small proportion of assessments:

I find exams to be totally unrealistic to what real engineering work is about. It is not possible to learn everything, that is what books are for, coursework is a much more realistic method of teaching engineering.

Open-ended response from questionnaire, man

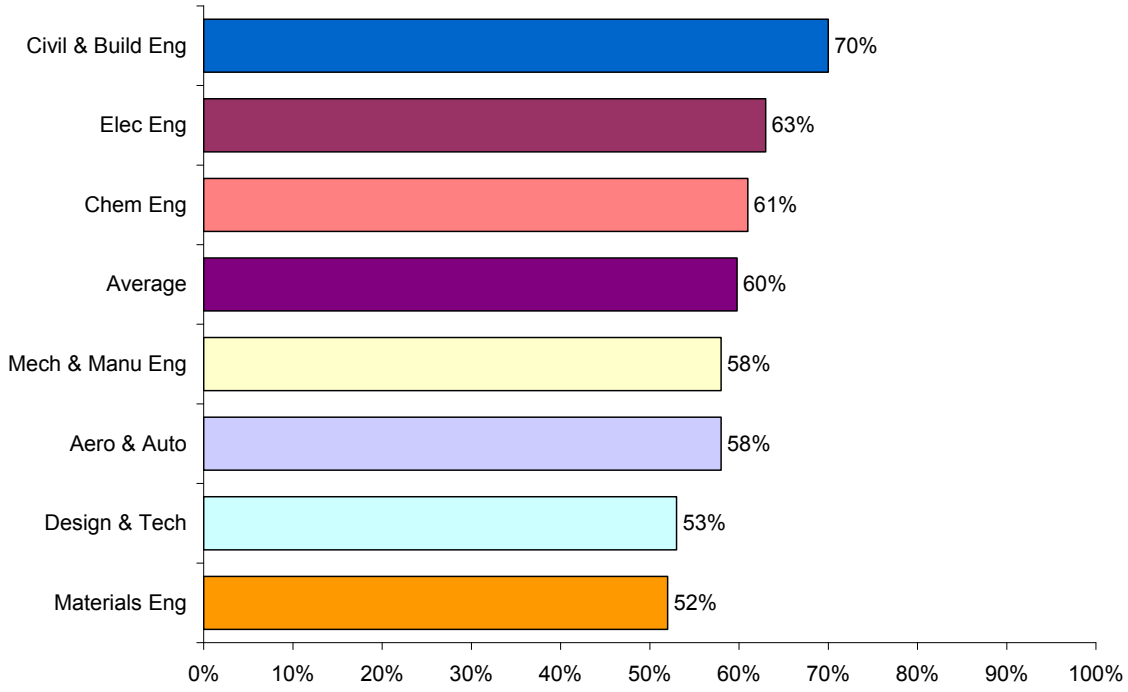
This quote also highlights a close relationship between the dichotomies of practical and theory work, and coursework and examinations. However, not all students favoured coursework:

The amount of coursework that we get is phenomenal … it's like we've got to hand in six pieces of coursework and an exam in two days.

Rebecca, Design & Technology student

As demonstrated in figure 6.9, the questionnaire indicated that on average 59.8% of students were satisfied with the quantity of coursework they have, although this does not show whether unsatisfied students would have liked more or less coursework. It could also indicate that the emphasis given to coursework varies by department. Furthermore, while the questionnaire showed that there were no significant differences by department, there were still some substantial differences with only 51.6% of Materials engineering students and 53.5% of Design and Technology students satisfied with the quantity of coursework they have, compared to 70.1% of Civil and Building engineering students.

Figure 6.9 Proportion of students who are satisfied with the quantity of coursework they have, by department



6.2 Relationships with other students

This section is concerned with how women engineering students interpreted their relationships with other students and looks at issues around peer camaraderie and competitiveness.

6.2.1 Peer camaraderie

Many of the students referred to bonding with their fellow course mates through the emphasis on group work and a shared understanding of the difficulty of the course.

> *All my course mates, they're really friendly and helpful, not like some other courses. Some other courses they don't know who are on the course and they don't communicate.*
>
> Victoria, Chemical engineering student

> *The best thing is the people you meet. They're all kind of like minded … because it's such a difficult degree everybody helps each other, like when we've got a really tough piece of coursework … the people who've done it will come over and help the people who haven't. It's a really nice spirit amongst everyone.*

Jenny, Aeronautical & Automotive engineering student

To an extent we didn't know each other that well in first and second year but I think you tend to – we all thought, blimey we got through this hell together. And so you manage to bond a lot more through that. So I think we've all managed to get each other, you know, get each other through it.

Paul, Automotive & Aeronautical engineering student

Well I've bonded so much more with everybody, because I see my course mates every day, all day. I've got a really good, sound group of mates and it's brilliant and, people I live with, they don't know anybody off their course.

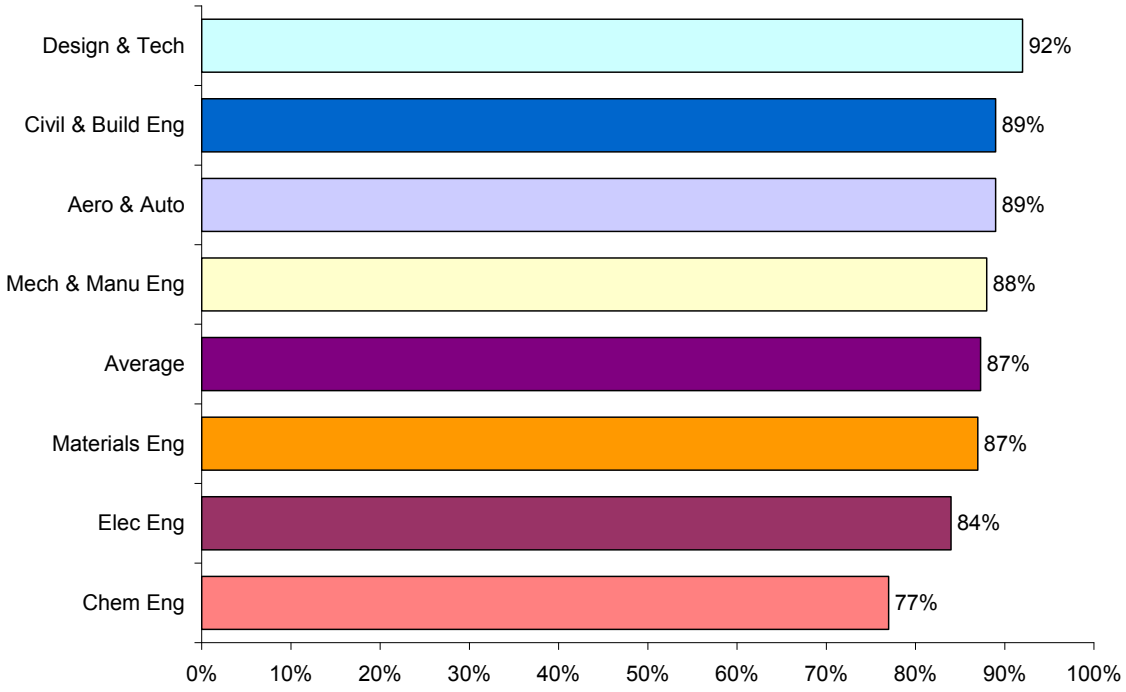
Fiona, Design & Technology student

We're all actually friends, so you feel you could do any sort of group work and you know you're gonna have a friend as it were, in your group.

Hannah, Civil & Building engineering student

Interviewees seemed to perceive this as significant because they felt it distinguished them from students on other courses, particularly in the social sciences and humanities. However, while the questionnaire showed that on average 87.3% of students were satisfied with the friends they made on the course, there was a significant difference by department ($F=2.27$, $df=6, 644$, $p<0.05$), with only 77.3% of students in Chemical engineering reporting satisfaction, compared to 92.2% of Design and Technology students (see figure 6.10). The Tukey HSD also showed that the difference between Chemical engineering students and Design and Technology students was statistically significant ($p<0.05$).

Figure 6.10 Proportion of students who are satisfied with the friends they have made on their course, by department



It also appeared that women attempted to fit in with their male peers by showing that they did not require special treatment and by sharing in the camaraderie they described. In 'acting like one of the boys', the women adopted traits and characteristics considered to be traditionally masculine in nature, as shown by Isabella:

> *I think to be a woman in engineering nowadays, you have to have a lot of character, and you have to have a lot of confidence in yourself and that you were right and that you could have those problems sorted out. And if you do have that, you have to be confident purely to inspire confidence and until you show that you're as confident as them, they'll take advantage of you and they'll just be…you've just got to be as big and loud as you can be.*
>
> Isabella, Mechanical & Manufacturing engineering student

A crucial element of 'acting like one of the boys' was for women to downplay their own gender. Successfully achieving this meant that women engineering students were not seen by their male peers as 'women' but rather as 'engineers':

> *They're* [male students] *all really good so it doesn't bother me now* [being in a male dominated environment]*, 'cos at least they see me as somebody else, they don't see you as a girl as such, so that's quite good.*

Amy, Mechanical & Manufacturing engineering student

However, as the open ended questionnaire response below shows, not all women were satisfied with how they were treated by their peers:

> *I was very surprised at how my fellow students treated me, being a female engineer. I have found their attitudes were very old-fashioned and sexist.*

Open ended response from questionnaire, woman

6.2.2 Competitiveness

While students reflected positively on the peer camaraderie on their courses, it also appeared that the environment where everyone knows each other also fostered a competitive atmosphere:

> *The course is a lot more competitive than I expected it to be … there are really, really nasty people who do not want you to succeed.*

Katie, Design & Technology student

> *It's quite competitive on the course. People know where people are in* [comparison] *to themselves so you don't want to fall behind.*

Samantha, Civil & Building engineering student

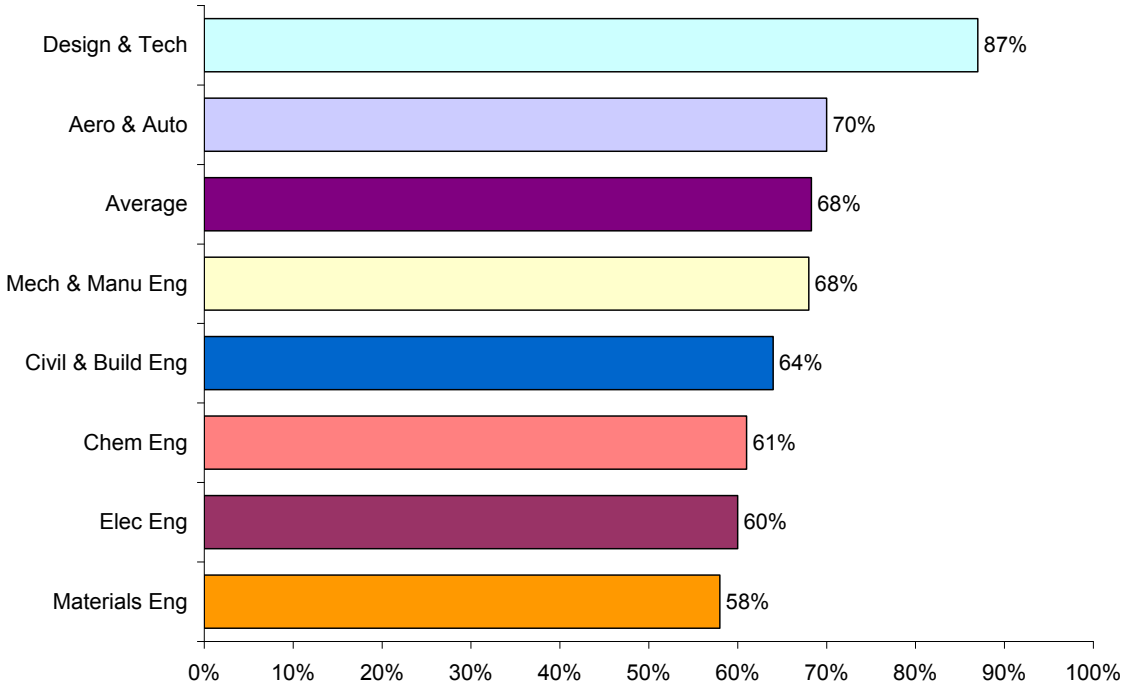
> *When you go up to university everyone's sort of a similar ability so you have to work a lot harder and it's very competitive, this course ... I suppose it's a good thing. If it's competitive it pushes your work to a higher standard.*

Daniel, Design & Technology student

This was strongly supported by the questionnaire with 68.3% of respondents agreeing that engineering students are competitive. There was, however, no significant difference between the views of men and women students. The most competitive department was found to be Design and Technology (87.1% of respondents agreed that students were competitive, as shown in figure 6.11), while the least competitive was Materials engineering (58.1% of respondents agreed that students were competitive). A one-way

ANOVA showed that this difference between departments was significant ($F = 8.165$; $df = 6, 643$; $p<0.01$).

Figure 6.11 Proportion of students that agree that engineering students are competitive, by department



At the same time women sought to overcome any perceived discrimination or negative attitudes about their gender by competing with the male students to demonstrate that they were good, capable engineers, who had earned the right to be an engineer:

> *We have to work harder to prove that yes, you are just as intelligent as the person sitting next to you.*
>
> Emily, Aeronautical & Automotive engineering student

> *To some extent, you've just got to kind of go and show them that you can do something. It's just that you've got to prove yourself to them, I think. I think that you've gotta like work harder and show that you actually do know something and you do use your initiative a bit more.*
>
> Holly, Mechanical & Manufacturing engineering student

> *Once I'd proved that I was there to just get on with it, I think that kind of barrier just went.*

Chloe, Mechanical & Manufacturing engineering student

Similar to 'acting like one of the boys', the women appeared to believe that by proving their ability to be 'good engineers', their gender would be insignificant. This is something of a paradox given that the women also felt they had to work harder than their male peers entirely to overcome the fact that they were women.

6.2.3 Communication

Also in contrast to the idea of camaraderie, many students suggested that communication between their peers, in relation to work (for example in group work), tended to be poor.

> *Communication was non-existent and I was left out in one way or another. They wouldn't tell me there was a group meeting … It was peer assessed … they marked me right down, which I felt was completely unfair because within the boundaries they'd placed on me, I'd done the best I could.*
>
> Andrea, Civil & Building engineering student

> *The bad experiences of group work … you keep calling the group, your group mates, and they don't turn up one week, to hand in your coursework, or some send emails and they claim they don't receive their emails. I mean you arrange meetings and no-one comes, those were the bad times of group work really. And then after the work's been done they claim that you didn't try to get hold of them.*
>
> Anna, Civil & Building engineering student

While this was not exclusively related to gender, it was sometimes discussed by women in terms of the difficulty of getting the 'boys' or 'guys' to listen to or take them seriously.

> *Trying to get the boys to listen to anything you're saying is difficult … the boys just wouldn't listen to a word that* [name] *was saying … I had to persuade them to listen to what she was saying, and I found that really frustrating that they just wouldn't listen.*
>
> Emma, Mechanical & Manufacturing engineering student

> *We're working in a group at the minute actually that's not particularly enjoyable because, well one of the guys is, I feel that he has the impression that you're just a*

girl, which I find quite annoying. So we don't really see eye to eye on a lot of things and I find him quite sort of domineering. He just came and took the role of leader, sort of like 'you will do this, this and this'. And there's no sort of leverage for different opinions in the group, so that's been a bit of a battle.

Amy, Mechanical & Manufacturing engineering student

Again, this may be related to the emphasis some women placed on competing with men and showing their worth as engineers. Some women students also suggested that male students could be patronising and undermining toward women students:

If you've done something wrong – if it's a lad they'd get scorned for it, whereas if it's a girl, you get 'oh, she's only a girl, what's she supposed to know about it? She's not as good as everybody else' … you're having to prove yourself continuously.

Isabella, Mechanical & Manufacturing engineering student

6.2.4 Humour between students

Discriminatory behaviour often seemed to surface under the guise of humour. One way in which women attempted to establish their identities as engineers appeared to be in the process of denying that they had been discriminated against, frequently seeking ways to justify their peers' actions. For example, they may suggest that their peers did not have the intention to discriminate, or that the consequence of their peers' actions was in the end good for them, despite the intentions. There were numerous examples of this, some of which are outlined below:

You get the obvious, you know, bits of perving and stuff like that, but you've just got to learn to take it in the spirit that it's meant.

Hannah, Civil & Building engineering student

Sometimes the lads'll make a joke, and they'll say, 'you're doing a boys course', or 'are you a lesbian?' That kind of thing. I don't think they actually mean it.

Tracey, Aeronautical & Automotive engineering student

Some women were less accepting of such behaviour, but still seemed reluctant to challenge it:

> *With being female you do get a lot of, sort of, tension, you sort of notice – all the men kind of just stare at you a bit and it's you know, a bit off putting, but yeah, just, just little things.*
>
> Jackie, Mechanical & Manufacturing engineering student

Within the structure of engineering organisations, the majority of women did not consider it feasible to challenge gender discrimination:

> *I don't think I would have much to achieve if I was to pursue sexual discrimination. I think it would highlight the case that women can be a bit of a pain in the arse.*
>
> Carolyn, Civil & Building engineering student

In this sense it seemed that accepting discriminatory behaviour contributed to women being accepted as engineers, or at least to minimising the risk of rejection as an engineer. Carolyn's quote also shows how when women are treated differently, the issue is internalised or individualised, in that the problem is perceived as personal rather than a result of gender. This may be because there are so few other women that they are unable to compare their experiences, but it may also allow women to retain a sense of control or agency since it is possible to change individual behaviour but rarely to change your sex.

6.3 Relationships with other women

As well as the general discussion about relationships with other students, the women also discussed their relationships with other women and their views on the scarcity of women in engineering. Generally speaking women were often found to say that they enjoyed working in a male dominated environment:

> *I'd rather work with men because the women on our course are all quite dictating. I do find it hard working with them because I think, in general, you tend to have similar qualities and it just gets quite difficult.*
>
> Holly, Mechanical & Manufacturing student

The women engineering students also sought to stereotype other women (usually those outside engineering) as ‘pink’, ‘girlie’, ‘bitchy’ and so on:

> *There are some really girlie-girls. My house mate was a really girlie-girl, but she dropped out. But she was like all pink, blonde, a ‘get away with anything’ kind of girl.*
>
> Alison, Mechanical & Manufacturing engineering student

> *I would say, definitely in the work environment, the girl-bitchiness side of things, that could interfere ... the way guys work, obviously they do gossip, but when its work, they're on it, and I like the fact they can separate the two and they can be a bit more professional about it.*
>
> Chloe, Mechanical & Manufacturing engineering student

This shows that women in engineering can be particularly critical of women outside engineering. This may reflect their decision to study a male-dominated subject, where they enjoy the company of their male peers, but it may also be a result of women’s desire to distance themselves from other women and their enculturation into a masculine belief system. Not only did the women hold stereotypical views of men and women, they were also highly critical and negative about other women:

> *I wanted to do* [engineering] *because not that many girls are doing it and, to be honest, sometimes I think that girls are irritating.*
>
> Michelle, Civil & Building engineering student

> *I don't like girlie-girls, they really annoy me.*
>
> Samantha, Civil & Building engineering student

6.4 Relationships with staff

This section describes how women engineering students experienced their relationships with lecturers and their personal tutors.

6.4.1 Lecturers

Remarks about lecturers and teaching primarily refer to male lecturers. While students were asked about their experiences of women lecturers, most students had either been taught by only one woman or no women. As such, most of the interviewees (women and men) did not feel that they were able to compare their experiences of being taught by women and men staff. Nevertheless, the students had a seemingly positive attitude towards their lecturers and teaching. They found them motivating and supportive, and a number of students viewed some of their men and women lecturers as role models and mentors:

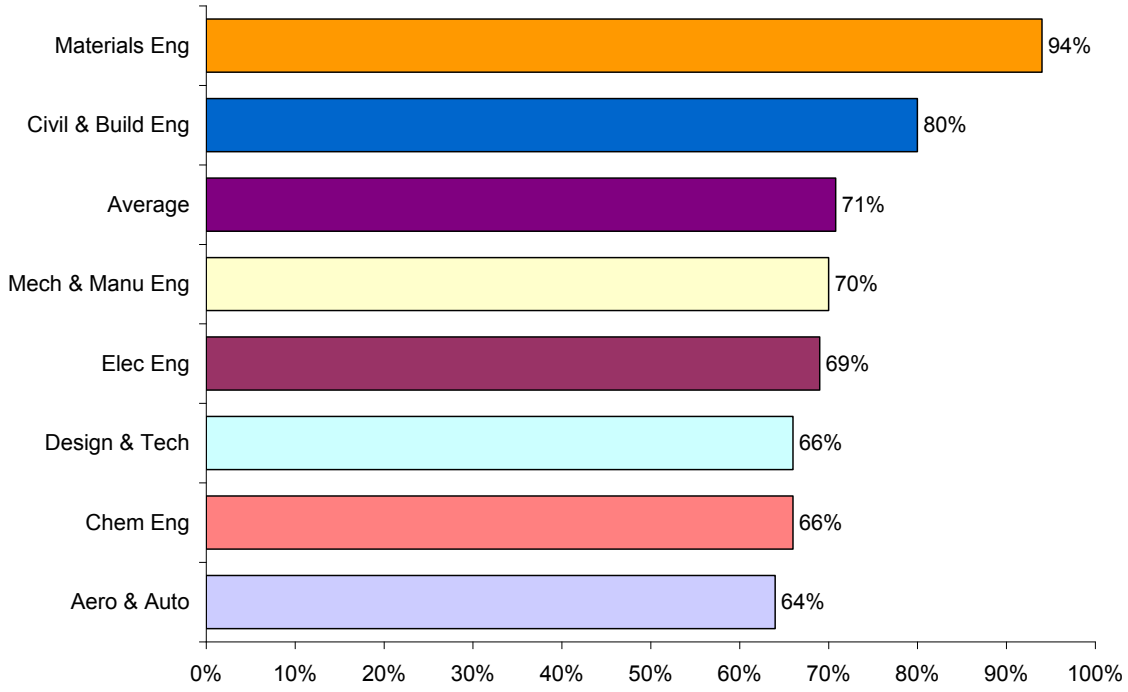
> *Some of the lecturers are quite good and it makes you think, I want to go into the industry, because they've been in the industry before … he'll tell you what sort of things have happened, and how it can be fun and exciting and it can sound very interesting.*
>
> Frances, Civil & Building engineering student

> *There's always the support there and the lecturers are really good. If you've got a problem you can always go and find them and get help.*
>
> Sophie, Mechanical & Manufacturing engineering student

> *We've got this really cracking lecturer called* [name]*, and he's been so enthusiastic, it's just like really good. I think it's the lecturers who make or break the course. We've got another one who is pretty boring.*
>
> Carolyn, Civil & Building engineering student

Similarly, the questionnaire showed that on average 70.8% of students were satisfied with the support they received from lecturers, although there was considerable difference by department. A one-way ANOVA showed that there is a significant relationship between department and satisfaction with support from lecturers ($F=2.86$, $df=6, 643$, $p<0.01$). Materials engineering students were most satisfied (93.5%), while Aeronautical and Automotive students were least satisfied (64.4%), as shown in figure 6.12.

Figure 6.12 Proportion of students who are satisfied with the support they receive from their lecturers, by department



A Tukey HSD test also showed that there was a significant difference between Aeronautical and Automotive students and Materials students ($p<0.05$), between Materials students and Mechanical and Manufacturing students ($p<0.05$) and between Materials students and Design and Technology students ($p<0.01$).

> *It's not so bad any more because they know us. But initially they were just like, I don't know, there was just something different. I can't put my finger on it but they, just, you can tell …*
>
> Sarah, Chemical engineering student

One student indicated that male lecturers might not be comfortable with women students:

> *Some of* [the male lecturers], *they're quite happy to sit and chat to the guys, but they don't really know what to say* [to the female students] *… it's almost as if you're not somebody who's normal.*
>
> Eve, Civil & Building engineering student

However there was also a sense of heightened visibility, with one student feeling singled out because of her gender when a lecturer complained to her personal tutor that she had

missed a lecture. The Civil and Building engineering student felt victimized because the lecturer failed to notice if male students were absent from class.

6.4.2 Staff humour

Although the questionnaire showed no significant gender differences with student satisfaction with support from either lecturers or personal tutors, similar to with students, gender differences were thought to be highlighted through the use of humour. A number of students highlighted gender issues when they spoke about their lecturers, such as staff making sexist banter:

> *Now and then* [male lecturers] *make … female jokes but I wouldn't say they necessarily treat you differently on purpose.*
>
> Amanda, Design & Technology student

> *I think they do* [treat women equally]. *One of my lecturer's always jokes around. There was this really loud bang in the workshop whilst we were cutting steel with a guillotine and I screamed. He was like 'Oi, girl'. You get little comments then, but they don't treat you differently for anything else. If you scream when you know it's gonna make a noise; that was just ridiculously girlie. I expected it.*
>
> Tracey, Aeronautical & Automotive engineering student

However this was invariably accepted as 'joking' by women and there was almost no evidence of the women challenging this behaviour:

> *They usually ask us a question and we don't know the answer, so we just get laughed at, but they do that to anyone really, it just, it's how the boys are.*
>
> Zoe, Aeronautical & Automotive engineering student

6.4.3 Help and support

In contrast to much of what has been shown in this chapter, some women also stated that there were particular advantages to being a woman in engineering. Women engineering students overwhelmingly stated they were more likely to ask for help, both in the engineering classroom and workplace. Also, their sex was, unwittingly, likely to ensure that they received more help and co-operation than their male counterparts:

There's this one assistant in our department and he is known for helping girls out more than boys … the boys get a bit angry.

Maria, Design & Technology student

Some of the older lab technicians can still be slightly biased towards wanting to help the female students. However this works both ways and I know of one lecturer who almost refuses to help girls unless pointedly asked.

Open ended response from questionnaire, woman

One lecturer does give us a lot more leeway than he'd give the lads. He'd expect the lads to know things, whereas with the girls he's sort of like 'oh you don't know it? Oh, okay'. I think there's a lot of fear on the lecturers' part. I think there's a lot of fear there, because somebody could turn round and accuse them of sexism and of picking on girls and all this kind of stuff, so they just tend to leave us alone.

Isabella, Mechanical & Manufacturing engineering student

Some of the boys on the course, they think that if you're a girl you're stupid, but that works to your advantage if you're stuck on a piece of course work, because you just play up to it, and then they help you. Whereas, they don't help each other.

Tracey, Aeronautical & Automotive engineering student

You can act stupid if you don't know something and don't get told off.

Erica, Mechanical & Manufacturing engineering student

While a number of women found this to be patronising, most perceived this as positive, with some indications that women purposely use their gender in order to get more help. However, this finding may indicate that women in engineering are perceived as less capable than their male counterparts; ultimately a fact which, in the future, may cost women in terms of promotion and which is counterintuitive to women's desires to be seen as 'good engineers' and not 'women engineers'. The quote from Catherine, below, also indicates that regardless of whether women have requested help or not, the fact they receive it may exasperate their male peers and 'undo' much of their attempts to 'fit in' to engineering cultures:

We do have someone in for electronics and he's male and he helps the females more and so the guys get annoyed about that and he's alright to help you. He's like 'oh let me help you with that circuit' and then the guys will come up to him and ask him and he's like 'oh well, oh you do it like this' but then sends them all off, so that's quite good using it to your advantage.

Catherine, Design & Technology student

Several students also felt they were put in an awkward position when staff appeared to offer them more help than male students because they were female:

Some [lecturers] *are fine, but there's some that always try and help you if you're a girl which is a bit annoying.*

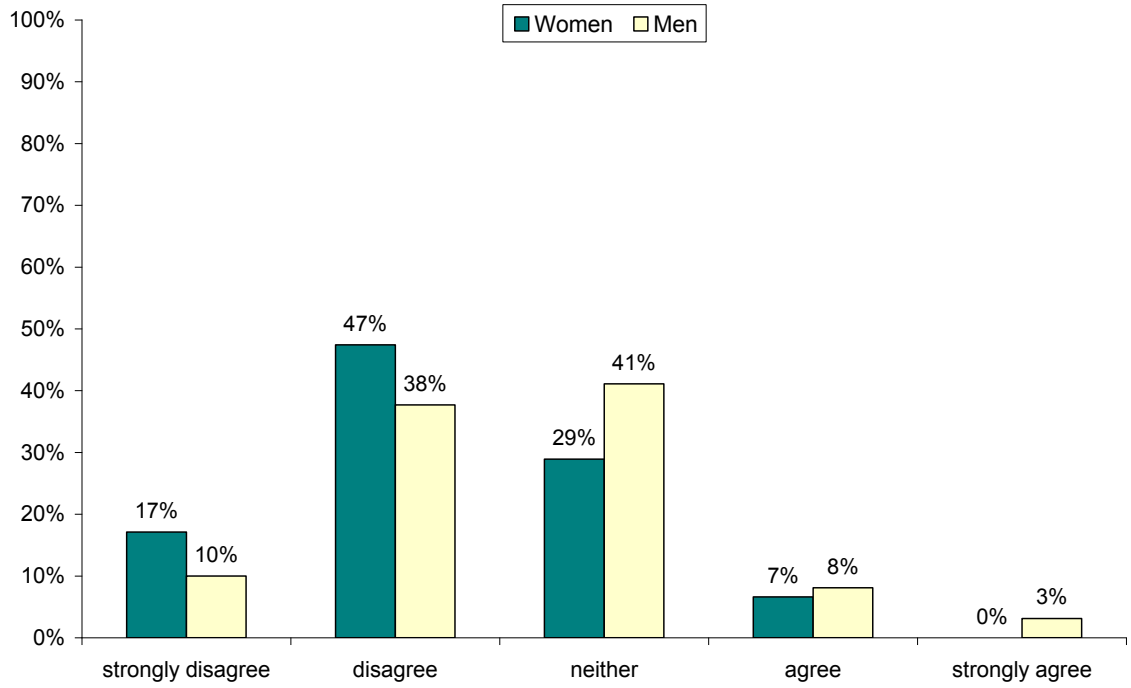
Jessica, Design & Technology student

People patronise you a little bit. Maybe that's just me, I don't know, but yeah you do get patronised a little bit ... It's nice [staff] *go all out to help you, but it can feel sometimes that it's because you're a girl that they go all out to help you and it can be a little bit sleazy. One guy … he's just really unbelievable. He'll take you from the back of the queue, bring you right in front of all these lads and help you – pretty much do it for you, which you're not going to complain if someone's offering to help, but then you get grief off the lads … they put you at a disadvantage.*

Fiona, Design & Technology student

Interestingly, the questionnaire showed that, on average, only 10.0% of respondents thought that female students get more help in class than male students, and only 6.6% of women agreed or strongly agreed with this statement, compared to 11.2% of men (as shown in figure 6.13). An independent samples t-test confirmed that there is a significant difference between women's and men's views on this issue ($t = 3.90$; $df = 641$; $p < 0.01$).

Figure 6.13 Proportion of students who agree that female students get more help in class than male students, by gender



Women students may be disinclined to admit receiving more help in class than male students for fear of being labelled less able than the male students. A one-way ANOVA also showed significant differences between students' views by department ($F = 7.087$; $df = 6, 643$; $p<0.01$). The department of Design and Technology had the largest percentage (30.7%) of respondents who perceived female students to get more help than males (see figure 6.14).

As indicated earlier, however, it may be that lecturers legitimately offer women students more help because they appear less confident with their work than male students:

> *I think some of the male lecturers are more helpful to the girls than to the guys … but then I think it might be because the girls come across as less confident that the teachers want to help them more.*
>
> Elizabeth, Design & Technology student

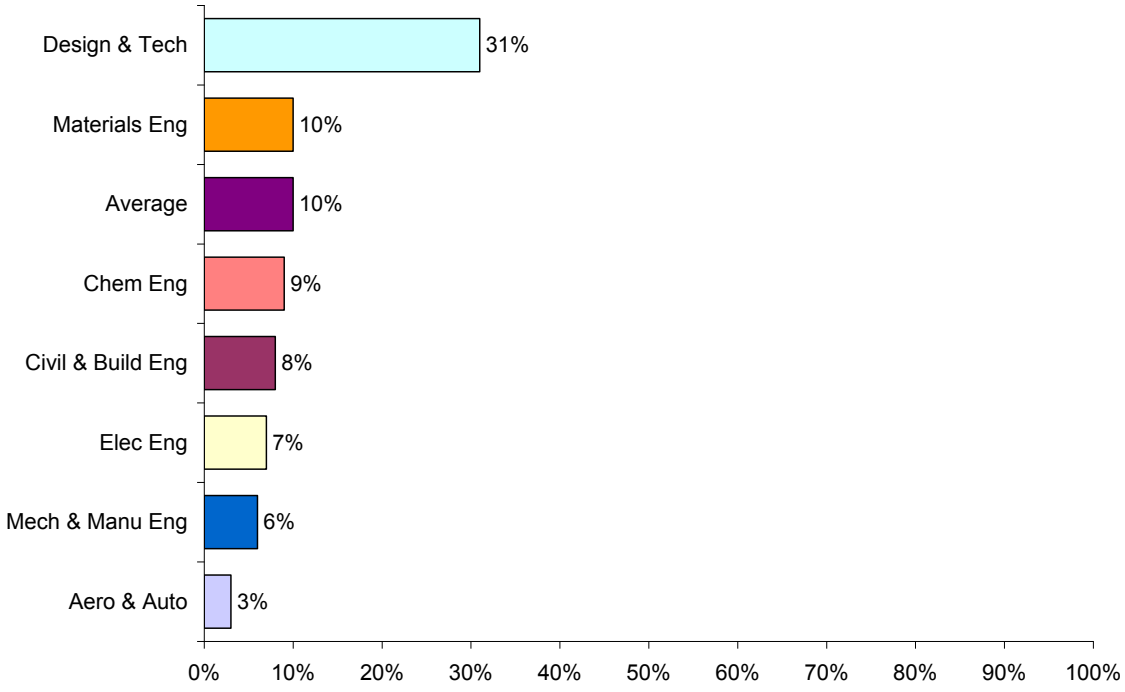
> *I think most of them treat us the same but sometimes maybe you can see that they are treating the male engineers better. But maybe because they are bolder, in the class they answer the questions and maybe that's why.*

Victoria, Chemical engineering student

They've got so much more confidence than us. I found that they were much more willing to go along and say that they knew something, even if they didn't. It'd be like, you know, 'how do we do this?' They'd say, 'oh I know how to do that' and then come out with something and you'd think you know, and say, well I actually don't know how to do this. I'm quite happy with someone else showing me how to do it. And they're very confident in any ideas that they have, that they're absolutely right and it's always gonna work and it's not.

Isabella, Mechanical & Manufacturing engineering student

Figure 6.14 Proportion of students who agree that female students get more help in class than male students, by department



However, it could also be argued that the additional help and support women students receive from staff reflects a misplaced belief by staff that they are actually supporting women by implementing a positive action approach towards them. This was hinted at by Maria, who suggested that lecturers may be over-cautious in their approach to women students because they have not previously been used to teaching women:

I think they're [lecturers] *still not quite used to teaching with girls. I think probably because a few years ago it would just be mainly boys and they're used to that and*

it's changing now, so there's more girls and so they don't quite know how to treat you and they're just a bit cautious maybe.

Maria, Design & Technology student

Alternatively, lecturers may help female students more because some women are able to manipulate male members of staff, or rather, use their gender to their own advantage, as this student indicates:

[Male lecturers] *feel like they have to look after you more but generally because that's the way I play it with them, because then you get what you want more.*

Lisa, Materials engineering student

This attitude was not, however, favoured by all students:

Most of [the lecturers] *will* [treat you differently] *up to a point. I mean if you blatantly push the fact that you're a girl, they will treat you differently.*

Alison, Mechanical & Manufacturing engineering student

However, the questionnaire showed that the majority of students did not think that male students were more confident in class than women students (only 25% of students agreed with this) with no significant differences by gender or department.

6.4.4 Personal tutor system

There were some mixed views on personal tutors, with many students perceiving the idea of the personal tutor as very positive.

I really feel like [my personal tutor] *really looks out for me. And I see him more as a final student or big brother figure.*

Katie, Design & Technology student

However, some students were also fairly critical of the personal tutor system:

I do find that our tutors aren't very approachable.

Catherine, Design & Technology student

It's not particularly pleasant going to talk to someone you don't know about issues that are quite personal to you. And you always think that your personal tutor should be that personal, approachable. Whereas I think I spoke to mine twice. There was two compulsory visits in the first year … and then after that we've not seen each other ever again.

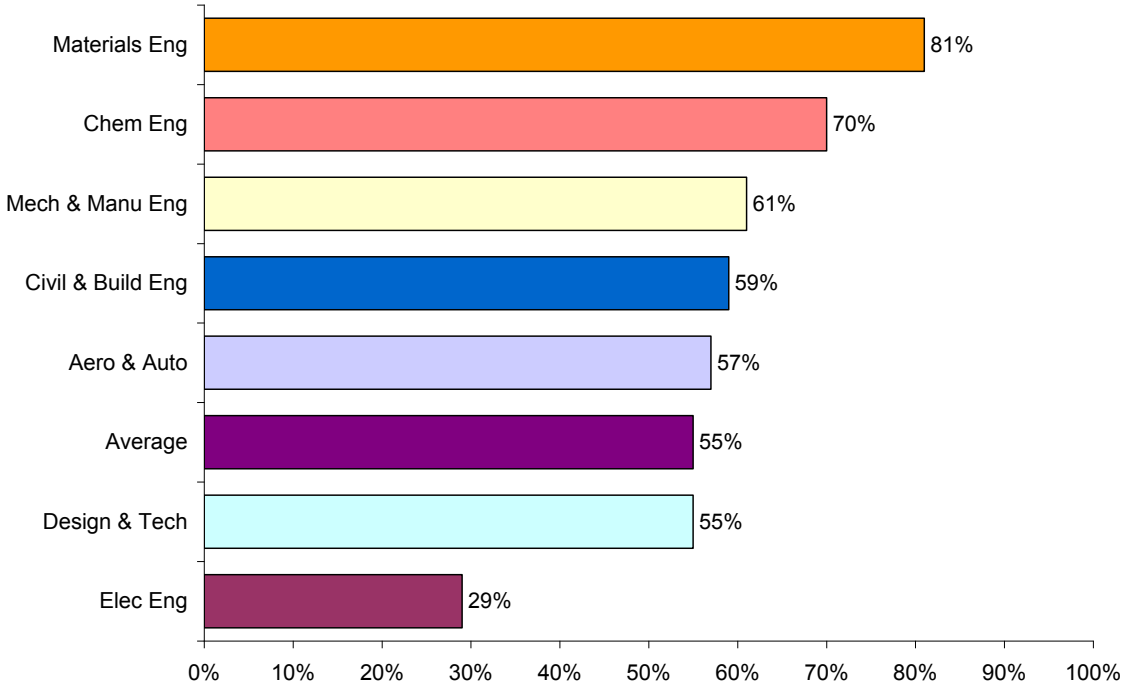
Paul, Automotive & Aeronautical engineering student

Another student felt that when she complained that the male students she was working with were treating her unfairly, her female personal tutor failed to take her seriously:

I told [my personal tutor] *there were boys who were harassing me … they'd end up giving me the work … I told her about it and she was like, 'well, it'll pass' … she didn't even call them to talk to them.*

Anna, Civil & Building engineering student

Figure 6.15 Proportion of students who were satisfied with the support they receive from their personal tutors, by department



The questionnaire showed that, on average, only 55.5% of students were satisfied with the support they received from their personal tutor, with considerable difference by departments ($F=7.82$, $df=6, 640$, $p<0.01$), ranging from only 29.2% satisfaction for Electronic and Electrical students to 80.6% satisfaction for Materials students (see figure

6.15). This suggests that there is a large difference in the extent to which personal tutor systems are implemented in departments. As the smallest department in the research, students in Materials engineering may also find it easier to approach staff with their concerns. The Tukey HSD statistical test also showed that there was a significant difference between students' satisfaction in Materials engineering and Design and Technology ($p<0.05$) and between Electronic and Electrical engineering and all other departments ($p<0.01$).

In addition, one student felt she was made particularly visible because of her gender and singled out when a lecturer complained to her personal tutor that she had missed a lecture. The Civil and Building engineering student felt victimized because the lecturer failed to notice if male students were absent from class.

6.5 Summary

- This chapter has addressed women's experiences of their engineering courses and their relationships with other engineering students, other women and engineering staff.
- The findings suggest that the majority of students are pleased they chose to study engineering and value the varied nature and diversity of their courses. However, at the same time, some students question the relevance of some modules and the intensity of their courses.
- Students also value the peer camaraderie on their courses, which, ironically, may be a result of the intensity of their courses. However, it also appears that this environment fosters a competitive atmosphere among students.
- While students were mainly complementary about their lecturers, there is some evidence of gendered behaviour and responses to women students. A particularly key issue here is the unsolicited help women appear to receive from staff, which, regardless of the intentions, has a profound effect on women, including making them highly visible as recipients of 'special treatment'.
- The analysis also reveals some key discipline differences, especially between Design and Technology and other engineering disciplines. Students in Design and Technology were more likely to find their course difficult and think that students were competitive. Women in this department were also more likely to state that they received additional help and support from staff.
- The findings also suggest that women engineers' gender is often a site of conflict in that it has simultaneous positive and negative effects. For example, women were the subject of gendered humour, which often undermined them, but they also seemed to relish their minority status and were highly critical of other women.
- Chapter seven, *Discussion,* explores in more depth the findings presented in chapters five and six in the context of existing literature and in relation to the research questions and objectives.

7. Discussion

This chapter discusses the main findings of the research presented in chapters five and six in the context of the existing literature analysed in chapters two and three of the thesis and the research objectives outlined in chapter four. The chapter begins by discussing some of the key points of the each of the findings chapters, developing existing models of career choice and describing the cultures of engineering education, before addressing some ideas concerning gender and identity, including the extent to which women challenge or maintain existing HE engineering cultures.

7.1 Career choices

The findings resonate well with the career choice literature, as most of the themes that have been identified as influencing career choice can be related to the categories in other career models.

Figure 7.1 Model of women engineering students' career choice

Similar to Carson and Mowsesian (1990) the research shows that career choice is a complex and dynamic decision-making process. The various factors that influence women's career choices are shown in figure 7.1 and discussed further below.

7.1.1 Socialisers

By discipline, students in Aeronautical and Automotive engineering were most likely to say they chose to study engineering because their hobbies and interests are of a technical nature; while Civil and Building and Chemical engineering students were least likely to state this. This suggests that the Aeronautical and Automotive courses were perceived to have the most technical content. The interviews and questionnaire showed that both women and men students were encouraged to study engineering by their teachers, disputing Evetts' (1996) and Gill et al.'s (2008) suggestion that women are more likely than men to credit a teacher with encouraging them to study engineering. Design and Technology students were most likely to say that their teachers influenced their decisions to study engineering. This is probably because Design and Technology is a school subject in its own right, unlike engineering. Nevertheless, a number of interviewees also said they were influenced by their physics teachers. As in previous research (Evetts, 1996), careers advisors were found to have relatively little impact on students' decisions.

7.1.2 Knowledge of the engineering professions

Knowledge of and about the engineering professions can be likened to what Jawitz and Case (1998) call 'contact with engineering career', which they suggest includes exposure to the engineering sector and career events. The evidence in this research suggests that this knowledge was rarely gained through careers advisors (similar to Evetts, 1996), but more often from family and friends working in the sector. Although careers events such as insight courses were also shown to be particularly effective in encouraging women to study engineering.

It might be assumed that knowledge or awareness of the engineering professions would be a prerequisite for studying engineering. However, this was clearly not always the case, with a quarter of all students questioned stating that they chose to study their course with little knowledge of what engineers actually do. Furthermore, women were more likely than men to acknowledge this lack of awareness and were also more likely than men to state that they were encouraged to study engineering by *someone* (rather than *no one*). This is similar to McIlwee and Robinson's (1992) finding that 90% of their women interviewees said they had no idea what 'being an engineer' involved before they entered the

profession. One explanation is that, as argued by Evetts (1996) students do not choose to study engineering on the basis of long-term career goals, but in order to pursue further the interests they developed at 'A' level. It may also suggest that women have a greater lack of knowledge about engineering (or at least, are more likely to admit this than men) and may be the reason why women appear to need more encouragement to study engineering at university than men. However, it would also be interesting to compare these findings with women's career choice in other disciplines such as business or psychology.

Students in Civil and Building and Aeronautical and Automotive engineering were most likely to state that they had no encouragement to study engineering. This may indicate that these are disciplines which people know, or think they know, the most about, in terms of the type of work that might be involved in the field. Electronic and Electrical engineering students, however, were most likely to have been encouraged to study the discipline by someone else, which may suggest that unless people are actively made aware of the field, for example, by someone encouraging them to study it, it is a discipline about which little is generally known by people entering the profession.

7.1.3 Skills, abilities and attributes

In relation to career choice, students participating in the research often made reference to their ability in certain subjects, mainly mathematics and science, their interest or aptitude for practical skills, and personal attributes they perceived made them suited to being engineers. These indicators are similar to what Shell et al. (1983) describe as prior educational experiences, and reasons cited by Jawitz and Case (1998) for choosing an engineering career, including school subjects and engineering activities, which they further detailed as including an attraction to practical activities, an enjoyment of problem-solving and a desire for challenges. The interviews indicated that women were strongly influenced by their ability in maths and science subjects and an interest in practical skills. However, the questionnaire did not find any significant evidence of gender differences, despite previous research which has found that women were more likely than men to be attracted to engineering by ability in maths and science (Kent and Stublen, 1995) and by work practices such as hands-on experience and problem solving (Evetts, 1998; Gill et al., 2008; Jawitz and Case, 1998).

This is also particularly interesting given the stereotypical views women held on the type of people best suited to a career in engineering, with suggestions, for example, that men are better suited to engineering because of the way their brains work. This reveals some

interesting tensions with women's accounts of their own experiences, ability, interests and motivations as individuals good at maths and science and who enjoyed practical skills and playing with 'boys toys'. Despite women's obvious ability (SHEFC, 1997, suggests women are often better qualified than their male counterparts) in these fields, often by their own acknowledgement, women continued to perceive differences between women and men as innate ('*girls can't think like guys*'). In upholding these stereotypes women seem to be disassociating themselves from other women and aligning themselves with their male peers: they are the exception to the rule. However, the reinforcement of the stereotypes also seems to pre-empt any criticism they may encounter in the sector and also justify any suspicions they may have of other women in the sector. Furthermore, these stereotypes are in stark contrast to women's perceptions that *any* woman could pursue an engineering career, if only they were interested in the subject. This may also relate to Volman and Ten Dam's (1998) suggestion that young people perceive gender inequality as a thing of the past and Rich's (2005) finding that young women are persistent in their belief that women and men face equal opportunities.

By discipline, Chemical and Aeronautical and Automotive engineering students were most likely to say they wanted to use their maths and science background without specialising in either. They were also most likely to say that they were good at maths and science at school. By contrast Design and Technology students were least likely to agree with both of these statements. At the university in the research, Chemical and Aeronautical and Automotive engineering are among the engineering departments which require both the highest 'A' level entry grades and specify that 'A' levels should include maths and either physics or chemistry. Design and Technology by contrast has lower 'A' level entry requirements and does not specify that A levels should include a specific subject(s).

7.1.4 Career rewards

Career rewards are concerned with how students' career decisions were motivated by factors such as long-term career prospects, salary and employability. These indicators are related to those which Dick and Rallis (1991) call extrinsic factors, Woolnough (1994) calls career aspirations, Shell et al. (1983) call work characteristics and Jawitz and Case (1998) also call career rewards. While the number of interviewees that had considered their long-term career ambitions was limited, some women and men knew that studying engineering would help them achieve their career goals, such as joining the Armed Forces.

However, a larger number of students had yet to make decisions about their future beyond university. This group seemed to have chosen to study engineering with a belief

that it would enhance their employability even if they chose not to pursue a career in engineering. It thus became clear that engineering students are not necessarily committed to pursuing a career in engineering. Similarly to the students in Metz's (2007) and Orndorff and Herr's (1996) research, students, women and men, thought that an engineering degree would be valuable regardless of the career they chose to pursue. This may go some way to explain the attrition of individuals from engineering education to engineering careers, particularly women (Kirkup and Keller, 1992). It also highlights the need for engineering courses to maintain students' interest in the field in order to encourage them to pursue a related career, as Jawitz and Case (1998) suggest. Interestingly, little previous research distinguished between choosing to study a subject and choosing a career, something which emerged strongly in the findings from both men and women. This may be because previous career choice literature has not tended to focus on the period of transition to HE. The exception to this is Etzkowitz et al. (2000) who write that educational experiences have a cascade effect on commitment, which can either be positive or negative. In other words, if students' experiences of HE are negative their commitment to their profession will be weakened, and vice versa.

A further aspect of employability was specific to the women, some of whom believed that their gender may increase their employability. This is because they thought that organisations may be seeking to employ women engineers to increase or improve the diversity of their workforce. This is similar to research by McIlwee and Robinson (1992) and McLean et al. (1997) who found that men perceived that women would find it easier to get employment because they were women. This clearly undermines women's status as 'good engineers' who are worthy of their jobs. This also seems directly linked to women's perceptions of gaining a place on their course, '*to balance out the numbers*' and had some negative consequences in terms of making women doubt their own abilities. It may also have more long-term consequences for women who perceive the engineering workplace as increasingly equitable, since 'getting in' to the industry, is not the same as 'getting on'. This is similar to patterns in the 'feminised' sciences, such as medicine, biology and pharmacy, which remain highly gender segregated and where the increased presence of women has not necessarily effected gender segregation (Fielding and Glover, 1999).

Salary was found to be important for a large proportion of students (over 40%), but men were found to be slightly more influenced by salary than women. This is strongly supported in the literature (see for example, Dick and Rallis, 1991) and may relate to societal expectations about women (Gattiker and Larwood, 198). Women, for example, were found to be much more likely than men to cite wanting to make a contribution to

society in their reasons for studying engineering, a factor Jawitz and Case (1998) call social identity and also shown to be gendered by Woolnough (1994) and Shell et al. (1983). Gill et al. (2008) also found that women appeared to have a strong social ethic. Women in this research were also found to cite wanting to be different (also shown in Kent and Stublen's 1995 research) or wanting to prove that they were as capable as their male peers. While this latter reason appears in contrast to the women who held stereotypical views of what women and men were capable of, or suited to, it is also further evidence of engineering women aligning themselves as more similar to men than other women.

7.2 Experiences of HE engineering cultures

Greenwood (1997) states that the culture of an organisation describes the unique way in which people act or interact within it. McLean et al. (1997) suggest that engineering education is dominated by a masculine culture characterised by a particular set of beliefs, behaviours and assumptions. The findings of women's experiences of engineering HE reveal a similar picture of the cultures of engineering education, a summary of which is shown in figure 7.2 below. These characteristics, symbols, values and behaviour were displayed through teaching and learning experiences and the relationships between staff and students, which are discussed in further detail below.

Figure 7.2 Cultures of engineering education

7.2.1 Course experiences

Course experiences included perceptions about the relevance of the course, difficulty of work, content of the work in terms of theory, applicability and practical work, and assessment methods. Teaching and learning methods are part of the structure of engineering HE that Lewis (1995) describes as 'strongly male biased'. While students' opinions in the research may not have been as strong as those expressed in the literature (Moxham and Roberts, 1995; Thomas, 1990; Srivastava, 1996), it is evident that the women students did not always approve, or feel comfortable with, curriculum content, assessment methods, the volume of work they had, or the emphasis on theory as work. However, the survey findings also indicate that male students may often feel the same, suggesting that the structure and cultures of engineering may be based on an outdated view of engineering as white 'macho' male environment.

A large proportion of students stated that it was difficult to understand the relevance of some modules. This was particularly found to be the case in Materials and Electronic and Electrical engineering and least likely to be the case for Design and Technology students.

Interestingly, the questionnaire showed that Aeronautical and Automotive students also had a low proportion of students questioning the relevance of some modules, but the interviews disputed this. This may be a result of the larger number of students interviewed from Aeronautical and Automotive engineering. The results may also reflect a lack of understanding or mis-communication in promotion materials, such as university prospectuses, about what is involved in the discipline.

Many students commented on the difficulty of their engineering course, a similar finding to research by McIlwee and Robinson (1992); McLean et al. (1997) and Thorn (2000). This was often framed in terms of the volume of work, as opposed to a lack of ability. Design and Technology students were most likely to think the course was more difficult than they anticipated while Aeronautical and Automotive students were least likely to think this. This could be related to the high ability of Aeronautical and Automotive students, who needed particularly high 'A' level entry grades, to include an A in maths and a B in physics, while Design and Technology students had much lower entry requirements. Related to the volume of work, was the concept of competing deadlines with Design and Technology students most likely to say they had competing deadlines and Electronic and Electrical engineering students least likely to agree. This could perhaps be better resolved through greater communication and planning between module leaders.

Perhaps related to the perceived relevance of modules some students were critical of what they felt was an over-emphasis on theory in place of practical or more applied work. This supports Madhill et al. (2003) and Srivastava's (1996) argument that hands-on experience is particularly influential for students. Students in Electronic and Electrical engineering and Aeronautical and Automotive engineering were least likely to be satisfied with the level of practical work they had, while students in Design and Technology were most likely to be satisfied.

7.2.2 Relationships with other students

Students described their relationships with other students in terms of peer camaraderie, competitiveness, communication and the use of humour. The survey showed that male and women students found engineering to be competitive; however, this finding is not conclusive. While the interviews indicate that women students perceive competition as negative, it may be that male students thrive in a competitive environment. Regardless of this, competition and poor communications appear to be an inherent part of engineering cultures, and while learning techniques (such as those Srivastava (1996) suggests) can be introduced to combat this, some will not always work. Group work in education, for

example, does not always lead to collaboration and the development of team skills (as in industry) because the university structure is individualistic; students achieve, and are awarded degrees, on the basis of individual merit.

Despite the emphasis on peer camaraderie, students reflected on the competitiveness between themselves. Students in Design and Technology were most likely to state that students on their course were competitive, while students in Materials engineering were least likely to agree with this. However, competitiveness can be interpreted as a positive or negative characteristic. Some of the interviewees, for example, described the competition as 'really nasty', while others felt it improved the standard of their work.

While most students felt they were treated fairly and justly, the women did encounter sexist banter and often felt undermined by their male peers and staff. However, students often dismissed sexist banter as 'only joking'. This may be as a result of women attempting to 'fit in' or being loyal to the majority group by allowing themselves to be a source of humour for the class (Kanter, 1977). An alternative explanation may be that, as noted above, women who have chosen to pursue a career in engineering have positive perceptions of the industry; they are unlikely to have chosen this course otherwise. Therefore at the early stages of their career sexist 'jokes' are interpreted as just that, jokes. It is only after years of consistent 'joking' that, for some women, what Etzkowitz et al. (2000) call the 'short-circuit' effect occurs, and women become disillusioned with their chosen career. While such banter and stereotyping may be accepted early in women's engineering careers, its future impact should not be underestimated. Future research may therefore ask women who have spent some time in industry about their educational experiences. These women will not only be able to reflect on the impact these experiences have had on their future career, but hindsight may also mean they are better able to reflect objectively on their experiences.

7.2.3 Relationships with staff

Students expressed a general satisfaction with their lecturers and personal tutors, but also raised issues about the use of humour and women receiving more help than male students.

Interestingly the questionnaire and interview data presented an anomaly on this, with male students more likely to agree that women get more help in class than women students in the questionnaire. However, it was also clear from the interviews that women did perceive that staff gave them more help than their male peers. What is interesting is that the

interviews indicate that women tended to receive this help regardless of whether they requested it or not, with mixed responses from women. One explanation offered was that staff perceive women to be less confident than men, but this is in contrast to existing literature which suggests the norm is for lecturers to assume that all students have prior 'tinkering' experience (Lewis, 1995). Nevertheless this can be regarded as creating a classroom atmosphere that made women feel uncomfortable (Lintern, 1995; Jolly, 1996; McLean et al., 1997), both in being singled out as lacking ability and by aggravating their male peers. Women's reactions to this are discussed further below.

Students in Materials engineering were most likely to state they were satisfied with the support they received from lecturers. This may reflect the fact that this department is the smallest of the engineering departments with only 125 undergraduates, which may enable staff the opportunity to get to know their students better.

By department, Design and Technology clearly stands out with almost a third of students perceiving that women students receive more help than their male peers. This finding was strongly supported by the interview data and the implications of this are discussed further below. Given that this department also has the highest proportion of women students (around 25%), it may be that any gender difference in the support provided by lecturers is more visible to onlookers.

7.2.4 Help and support

McLean et al.'s (1997) research with male engineering students shows that women were undermined by allegations of special treatment, such as additional help, by lecturers. It could also be argued that the additional help and support women students receive from staff reflects a misplaced belief by staff that they are actually supporting women by implementing a positive action approach towards them. Martin (2006), for example, suggests that *"well-intentioned, 'good people', practice gender in ways that do harm"* (2006: 255). Her research indicates that the help and support the women students receive is a result of male staff practicing *"a kind of paternalistic masculinity intended to be helpful"* (2006: 263). Thus staff may be trying to help women in the knowledge that they are a minority group that may need additional support or help 'fitting in', but are unaware of the consequences and feelings the behaviour creates for the women involved. The behaviour is therefore problematic because it reinforces a stereotype that women need men's help. It is also problematic in a more immediate sense because the 'extra' help was not something requested by women and had a profound impact on women.

The perception that women were receiving more help from lecturers than their male peers was interpreted in various ways by women. However, this was clearly something not encountered by men. The help seemed to be difficult to reject and created some tension with male students who saw women receiving favourable treatment. Being treated as a 'special case' also seemed to undermine women's attempts to show that they deserve a place in engineering because of their ability. Some women also seemed to interpret this behaviour as a sign that the engineering industry is positive and friendly towards women. It may also act as a barrier to women developing their practical skills to the same extent as their male peers, which may have consequences for their future career progression. Also, even if women perceive the help in a positive light, they may be *seen* as less capable than their male counterparts because of the extra help they are receiving. For example, while it may seem useful to get extra help, if this behaviour persists in the future it may result in women being overlooked when promotion decisions are being made, if women are perceived by employers as requiring extra help and support to succeed in the workplace. Thus, as women continue in their profession, they may realise that issues that are currently viewed as positive, can hinder them from progressing in their careers at the same rate as their male colleagues (Dainty et al., 2000). This also poses the question of whether 'getting in' is the same as 'getting on' in engineering industries. This is particularly relevant given that research on 'feminised' SET disciplines, such as medicine, biology and pharmacy, remain highly gender stereotyped and segregated (Fielding and Glover, 1999).

7.2.5 Anomaly of Design and Technology

As Wajcman (1998) states, a variety of cultures, or subcultures (Brown, 1995), can exist within a single organisation or entity. This research explores whether such subcultures exist between the disciplines or departments within the organisation of the university in the research and more generally in engineering education. Some experiences varied by discipline regardless of gender, suggesting that there are nuanced cultural differences between engineering disciplines and that it is not a homogenous sector. For example, Aeronautical and Automotive and Civil and Building engineering students were most likely to say that nobody encouraged them to study engineering. This may suggest that there is more widespread knowledge about what a career in these fields involves. Aeronautical and Automotive students were also least likely to say that they found their course to be harder than expected, possibly a reflection of the fact that the courses in this department had the highest 'A' level entry requirements. However, by far the most significant discipline difference, as shown by the qualitative and quantitative findings, was that

between Design and Technology and the other engineering departments. Design and Technology students were:

- most likely to be influenced in their course choice by teachers, probably because Design and Technology is a specific school subject, unlike engineering;
- least likely to say they wanted to use their maths/science background or that they were good at maths/science at school, reflecting the fact that this department had the lowest 'A' level entry requirements, both in terms of grades and specific subjects;
- most likely to say they found the course more difficult than they expected, again a reflection of the entry requirements, but also the high level of technical content involved in this specific Design and Technology course;
- most likely to say that students were competitive, perhaps reflecting a lack of collaborative work and the departmental culture.

Some of these differences are clearly a result of the discipline differences between Design and Technology and engineering (the first of which is arguably more creative, and the latter more technical) and the different university entry requirements between subjects. However, Design and Technology also revealed some of the most gendered behaviour, which is not satisfactorily explained by subject or discipline differences. For example, more than in any other department investigated, women were perceived to receive more help and support from staff than their male peers. The consequences of this have already been discussed, but it is particularly interesting given that this department also has amongst the highest proportion of women students (24%). One explanation of this may be that when there is a higher proportion of women present, it is harder to personalise or individualise gender biased behaviour or actions. For example, if a woman is treated differently and she is the only woman present, the difference can be attributed to personality or lack of ability, but if the woman witnessed several women being treated in the same way, albeit differently to men, it would be more difficult to explain in the same way. Interestingly this argument may support the critical mass theory, which has been disputed elsewhere in the thesis, by suggesting that there is a 'tipping point' where women have a greater awareness of gender issues (and perhaps as a result start to challenge cultural norms). However, this does not offer a complete explanation given that Chemical engineering has the highest proportion of women engineering students (27%) and limited differences with the other engineering disciplines in the research. If, as indicated above, the additional help women receive from staff is an attempt to support women in a male-

dominated environment, it could be argued that staff in Design and Technology are actually among the most gender conscious. However, given the impact it has on women, this is clearly a misguided approach.

7.3 Women engineering students' identities

Hofstede (2003) states that culture is something that is learned, but it is also simultaneously the shaper of human action and the outcome of human action. This section of the discussion is therefore focused on exploring women's gendered and professional identities and how they shape, and are shaped by, engineering education cultures as discussed above. The findings and discussion above reveal how women engineering students develop and manage their identity. As Paechter (2001: 49) argues, gender is not a given, it is a performance, and '*we demonstrate our gender identity, by and large, by the playing out of gender roles, and these roles are learned – usually unconsciously*'. The performance of gender was particularly evident through the strategies women were found to adopt for coping in a male-dominated environment.

This section explores how gender and engineering cultures shape these women's identities. This reveals a variety of issues, some overlapping and many contradictory. This may indicate that the issues discussed operate on a subconscious level for the women involved in the research and as a result of negotiating complex discourses concerning their relationship with gender and engineering (French, 2005). As Rich (2005) suggests, conflicting views may occur because women adopt an 'individualist position' that makes it difficult to challenge the structural constraints they face. Alternatively, or in addition, it may be that in many instances the research interview seemed to be the first time women had consciously thought about some of the issues raised. This is supported by Martin (2006) who states that people routinely practice gender without reflecting on it. It may seem surprising to an outsider that the women had often not considered the fact they were participating in a male-dominated environment. However, this is often what these women have been used to as a result of the choices they have made in their hobbies and education. For example, it was quite common for women to state '*I'm used to it*', since they had been the only woman, or one of very few women, among their peers for a long time. University was not their first experience of being in a minority, since this had often been the case during their study, particular for example, in maths and physics 'A' level classes, and in their hobbies, for example as RAF cadets.

Some of the issues outlined below have been described elsewhere as strategies for coping or surviving in a male-dominated environment, but this section considers that these

factors are also part of a process of negotiating and establishing gender and professional identities, which, as shown below, can often be in contention with each other. Evetts (1996), for example, suggests that the concepts of 'strategy' and 'identity' emphasise the actions, experiences and choices of women and incorporate the processes and constraints women have to negotiate and manage.

7.3.1 Claiming a rightful place

Various aspects of women's behaviour seemed to involve attempts to 'act like one of the boys'. This was particularly displayed through women's relationships with other students, where they highlighted the camaraderie and close relationships between students. They also discussed the need to '*be confident*' in order that male peers did not take advantage of them. There was also some evidence of this in career choice, where some women appeared to relish the challenge of working in a male-dominated environment: '*I'm gonna show them*'. In this sense the women also seemed to align themselves more with their male peers than with other women. This is discussed in more detail in section 7.3.3 *Queen Bee Syndrome.* This behaviour is similar to what Sheppard (1989: 146) describes as a strategy of '*blending in and claiming a rightful place*'. Sheppard found that 'blending' depended on the management of being both feminine enough, in terms of appearance, self-presentation and acceptance of expectations, and business-like enough, in order to claim a place in the organisation. Moreover, Knights and Kerfoot (2004), for example, found that 'career-women' demonstrate '*that masculinity is not the exclusive preserve of men.* [Women] *apparently see no alternative other than to emulate men in order not to be compared negatively with them or to suffer from the stereotypes that masculine hegemonic organisations reproduce'* (2004: 447). Schmitt et al. (2003) also argue that conforming to organisational norms and displaying masculine behaviour may be necessary to avoid stereotypical performance expectations based on one's sex. However, this strategy can also backfire, as women who conform to masculine work roles may be penalised for not being 'womanly enough', although there was no strong evidence of this in this research.

In a comparable study, the women in Evetts's (1998) study argue that it is necessary to be a good engineer. Focusing on building a reputation and earning respect, women engineers perceived that they would be seen as engineers first, women second, rather than women first as was often the case. However, Evetts argues that problems and difficulties remain, particularly in relation to career and promotion in the organisation. To build a reputation and to become a good engineer can be extremely difficult when there is

much competition surrounding career development and promotion, where there are numerous highly motivated, achievement-oriented individuals competing for every promoted post. Women in this research also discussed their desire to be accepted as good engineers, which they felt meant their peers no longer, '*see you as a girl.*' Despite descriptions of attitudes and experiences to the contrary, Walker (2001), similarly, found that women engineers perceived that the only thing that matters was their ability to do the job well (and not their gender).

7.3.2 Subtle discrimination

It also seemed that women were reluctant to admit they were being discriminated against, either failing to see their experiences as gendered or seeking to justify their peers' actions. Building on these ideas it seemed commonplace for women to view their gender as immaterial. This may be a result of a more general belief in the existence of equality for women and men, and a perception of sexism as a thing of the past (Volman and Ten Dam, 1998). In the focus groups, for example, women expressed their belief that few young men hold sexist views, which they described as '*age-old*', effectively a thing of the past. Even among older men, there was a perception that sexist behaviour would not occur because these men would not want their daughters or grand-daughters to be treated this way. This supports French's (2005) claim that women often insist that they work in a gender-neutral territory that has equal opportunities for men and women. This aspect of culture may also be likened to that which Maddock and Parkin (1993; 1994) call 'the gender blind': the perception that women can function in the same way as men, regardless of cultural or structural constraints or obstacles (see also Rich, 2005). However, they primarily saw men as 'gender blind', rather than women, as in this research. Madhill et al. (2007) suggest this is part of women's strategy to minimise 'differences' between themselves and their male peers and that even women who recognise the systemic nature of the issues they face are likely to adopt these 'survival' strategies.

Furthermore modern prejudice and discrimination against women has become increasingly subtle and covert (Benokraitis and Feagin, 1986) meaning that it is harder for women to identify instances of discrimination as such (see also Martin, 2006). This can be particularly significant in terms of humour and joking, where sexist attitudes were most commonly expressed. Holmes (2000) for example, suggests that unacceptable behaviour embedded in superficial humour, is particularly difficult to challenge because the joker remains friendly and it is likely to be the challenger that is ostracised by colleagues for 'not

taking the joke'. Acceptance of gendered and sexualised humour was seen in this research and is part of what Maddock and Parkin (1993; 1994) refer to as 'the locker room' culture. However, in keeping with the discussion above, this was in no way perceived as discrimination by the women students. Thus women discussed '*bits of perving*' and being asked if they were a lesbian because they were doing a '*boy's course*', but dismissed this as '*just little things*' that need to be taken '*in the spirit that it's meant*'. Another feature of subtle discrimination was the help and support women received from staff, discussed above, which clearly distinguished women students from their male peers, with potential negative consequences. However, this was rarely interpreted negatively and sometimes, as the description 'help and support' suggests, was perceived as demonstrating men's acceptance of women into engineering.

Whittock (2002) also suggests that the option of challenging discriminatory behaviour is likely to be dismissed due to the risk of exclusion or isolation. She calls this 'boundary heightening'. Schmitt et al. (2003) explain that women will tend to avoid perceptions of social reality that have negative implications for their social identity unless evidence for those perceptions is unambiguous. In other words, perceiving one's performance as the cause of a negative outcome is less damaging to an individual than perceiving discrimination as the cause. Furthermore, Walker (2001) also suggests that, as a result of normalisation, rather than gender equity, women engineering students are either ambivalent towards, or reject, gendered explanations of their experiences.

7.3.3 Queen-bee syndrome

The women provided evidence of passively performing masculine gender by conforming to dominant, hegemonic masculinity and by rejecting femininity. For example, the career choice findings showed that the women engineering students held very stereotypical views of women and men and 'innate' differences (such as '*the way the brain* works'), which they thought made men more suited to a career in engineering than women. Women engineering students were found to value their status as 'a novelty' in engineering. In this sense, the women align themselves with (male) engineers rather than other women; they perceive themselves as more masculine than feminine. This was illustrated by the women who stated: '*I'm quite laddish*', women engineers are '*quite aggressive*' and have '*stronger personalities.*' Sinclair (2005) suggests that the 'Queen Bee' syndrome – a reluctance to associate with other women, and appearing more 'macho' than some men – may simply be a result of being more comfortable with men than women. In the case of women engineers, these women have often become

accustomed to a male-dominated environment through technical hobbies, and the choices they have made in education. However, Rich (2005) and Budgeon (2001) indicate that women's perceptions of equality can result in a disdain for those women who appear weak or to have 'failed' to exercise their individual choice where they succeeded. Whatever the origins of male-identification, Sinclair goes on to say that *'these women enjoy the company of men, share interests and aspirations that are typically characterised as masculine, and perhaps seek their approva*l' (2005: 139). This is also similar to what Maddock and Parkin (1994) describe as 'the women as gatekeepers' culture, whereby women resist the idea of other women entering their workplace, occupation or profession. However, the relationship between engineering cultures and women's behaviour as 'queen bees' and 'gatekeepers' is a complex one, as shown further in the discussion below.

7.3.4 Assimilation

The attitudes and behaviour described above (claiming a rightful place, subtle discrimination and queen-bee syndrome) may be a result of women's assimilation or professionalisation into engineering cultures (se also Dryburgh, 1999; Faulkner, 2006). To some extent, this results in women engineers considering themselves as 'different' both because of the type of work they do and because the work they do is associated with men (Henwood, 1998). However, the attitudes and behaviour might also be considered to be 'coping strategies' (Evetts, 1998) or mechanisms for surviving in male-dominated cultures. Maupin and Lehman (1994), for example, found that, in a study of accounting organisations, it was necessary to suppress or eliminate attitudes and behaviours that would identify individuals as 'typically female'. Adopting an 'anti-woman' approach is a further way of dis-identifying with one's own gender, and arguably a strategy adopted in order to succeed in the workplace (see also, Goffman's (1959) 'impression management'). Either way, such attitudes fail to question let alone challenge the status quo. Any career success among such women is unlikely to promote the interests of women in the sector generally (Greed, 2000). It also raises questions about the concept of a 'critical mass': the idea that once there is a sufficient proportion of women in engineering, traditionally masculine cultures will no longer prevail. Williams and Emerson (2001), for example, suggest that if women account for at least 30% of the workforce the existing cultures may be challenged (see Powell et al. (2006) for further discussion of critical mass). However, as Sinclair (2005) highlights, by the time women achieve positions of formal power they have learned and share similar influencing strategies to their male colleagues: *'they have become enculturated*' (2005: 110). This was also shown in Küskü et al.'s (2007) research

with engineering students in Turkey, where gendered prejudice was found to persist despite women accounting for 35% of engineering students.

7.3.5 An (un) balancing act?

The assimilation or coping strategies described above are also problematic in that they position gender as a site of conflict for women, whereby gender is performed and negotiated as it is deemed appropriate in any situation. As Martin (2003) states, it is useful to question whether women 'choose' to adopt this behaviour or whether it is a reaction to their situation or circumstances, for example, because it is required to 'succeed' or because it is what expected. Women might be considered to use their agency to act within these social constraints (masculine engineering cultures) by consciously and subconsciously adopting the coping strategies described above. In addition, whilst there are multiple masculinities and femininities that can be performed by anyone, only 'traditional' masculinity performed by men is valued in engineering cultures specifically and by society generally. Martin argues, for example, that *"playing by the rules does not guarantee success because men may not perceive women as 'succeeding' even when 'objectively' they do"* (2003: 361). This means that women in engineering face further role conflict because they are perceived as defective women for choosing the 'masculine' occupation of engineering, and also as defective engineers because they are not men. In other words, while some women engineers may deny or reject femininity in order to gain acknowledgement, only male masculinity is likely to be accepted because this appears to be the norm (Halberstam, 1998). This reinforces the argument for moving beyond a bipolar distinction between masculinity and femininity, the interdependence of which is hierarchical (Gherardi, 1994) treating 'male' as superior and 'female' as a derivate or 'other'.

Butler (2004: 2) suggests that '*certain humans are recognised as less than human, and that form of qualified recognition does not lead to a viable life. Certain humans are not recognised as human at all, and that leads to yet another order of unliveable life*'. Applying this to engineering, women are caught in an ambiguous, double-bind where they can choose to be accepted, for example by acting like 'one of the lads', but simultaneously deny their gender, or choose not to be accepted all. Bagilhole et al. (2006) found that women engineers often chose to flee their gender declaring themselves 'engineers' not 'women engineers' who fail to realise that it is primarily appearance that is socially exclusionary (Garland-Thomson, 2005). Miller (2002: 154), for example, found that despite women's occupational and organisational values, beliefs and behaviour being

consistent with traditionally masculine norms, they still described feeling like 'outsiders', as they were criticised if their behaviour 'slipped' to reflect more feminine values. Miller suggests this is testament to the absoluteness of the general belief in a binary gender system. Miller goes on to argue, that while gender is socially constructed and separate from sex, this has little effect in reality. While women engineers destablise gender roles by acting like men, the salience of the perception that they are still women takes precedence (Miller, 2002). It is therefore important to develop a positive gender identity for women engineers.

Some conflict may also occur because of the implication that women now compete on equal terms with men (Wajcman, 1998). Certainly the formal implementation of equality policies is widespread, and as a result, there is much less overt sex discrimination. However, rather than dying out, male power is being reconstituted in a new form and the new gender regimes are oppressive to women in their own way (Wajcman, 1998: 30). MIT (1999), for example, found that women science academics began their careers with the perception that gender discrimination had been solved, but later realised this was not the case. Rather *'their eyes were opened to the realization that the playing field is not level after all and that they had paid a high price both personally and professionally as a result*' (MIT, 1999: 9). In order to succeed, women are compelled to deny aspects of themselves and to become more like men. However, systematic inequalities between men and women ensure that their experiences cannot be the same. Women are constituted as different kinds of workers because of their relation to the domestic sphere and because their bodies are sexualised to a degree that men's bodies are not.

As Gherardi (1994) points out, the multiple contradictions and ambiguities make 'doing gender' difficult to deconstruct. In order to make sense of the findings presented in this thesis, it is useful to perceive of multiple masculinities and femininities in the doing of gender. While this idea of gender multiplicity has been critiqued for leaving the gender divide in place (Linstead and Brewis, 2004), its use here is not intended to reproduce the hierarchical divide between masculinity and femininity, but rather, to provide a framework that allows researchers to explore the 'doing' and 'undoing' of gender. In this sense, the construction of 'men' does not accrue exclusively to the bodies of males or mean that 'women' will interpret only into female bodies (Butler, 1990). Thus a certain sex does not necessitate a certain gender, although there are powerful social constraints (Cole, 2000). Individual women combine traditional perceptions of both masculinity and femininity. Thus, as demonstrated in the research findings, women engineers are neither 'typically' feminine nor 'typically' masculine. This is because they challenge stereotypical notions of

femininity by usurping so-called innate differences and by being '*laddish*, '*aggressive*', '*strong*' and '*ambitious*'; by being engineers. Yet, on the other hand, they are not 'typically' masculine because they have to work harder than their male peers in order to prove they are 'equal' to them ('*you've got to prove yourself to them*') and they continue to be treated differently to their male peers, as subjects of gendered humour and in receiving 'help and support', for example.

It is also important to note that different masculinities and femininities will be adopted and performed, both actively and subconsciously, at different times by individuals. Thus, in order to survive, it is sometimes necessary for women to 'act like one of the boys', proving themselves as capable engineers, and at other times to accept the 'subtle discrimination' they face in terms of gendered humour and help and support. These survival strategies are a finely tuned balancing act. Sinclair (2005) argues that women may well prove to be bi-gendered in their approach. That is, they learn an array of influence tactics depending on the context, who they are working with, how much power they have and whether influencing upwards or downwards. This goes someway to explain the apparently contradictory attitudes of women engineers in this research. For example, at one given time it may be necessary for women engineers to 'achieve a reputation' as a competent engineer, but at other times women will accept offers of help from their male peers. While these are very different strategies, they both have the same aim: to gain acceptance. Thus the women engineering students were found to perform their gender in a number of ways as part of their assimilation and professionalisation into the engineering industries, but also for themselves, because '*we create and reinforce our gender identity by the performance we put on'* (Paechter, 2001: 50). However, both gender performance and gender conflict depict women as organisationally abject; 'overexposed' on the one hand, and yet 'isolated' on the other, which Cohen and Tyler (2007: 11) suggest is a result of living a '*negotiated, negated identity*'.

7.4 Summary

- This chapter sought to interpret the findings of the research on engineering career choices and experiences in HE in the context of existing literature.
- It shows that career choice is a complex and dynamic decision-making process, in which both women and men are influenced by socialisers, knowledge of the engineering professions, skills, abilities and attributes and, career rewards. However the extent to which aspects of these indicators are important is gendered, with gender differences apparent in awareness of engineering, employability and salary.
- It demonstrates the gendered nature of some of the characteristics, values, symbols and behaviour that make up the cultures of engineering HE and which were revealed through analysis of course experiences and women's relationships with other students and staff.
- While the gendered nature of the engineering courses seems to have some negative consequences for men as well as women, the experiences of relationships appear more specific to women. Key aspects of this include the gendered or sexualised humour experienced by women and the unsolicited help women receive from some male lecturers and technicians.
- The analysis also reveals that subcultures do exist within engineering education, with Design and Technology, in particular, having some significant differences to other engineering departments. Amongst these differences were gendered behaviour, with students in Design and Technology most likely to think that women receive more help and support from staff than their male peers. This is interesting given the high proportion of women students in this department (almost one quarter of all students).
- The chapter also considers some of the explanations and implications of career choice and HE engineering cultures in relation to women's identities. It shows that women's survival or assimilation into engineering cultures is based on a finely tuned balancing act between their gendered and professional identities, demonstrated through their implicit and explicit efforts to claim a rightful place in engineering, to accept the subtle discrimination they face and attempts to distance themselves from other women. This process of negotiation demonstrates women 'doing' and 'undoing', or performing, their gender in their everyday lives.

- The research therefore suggests that while the relationship between women's identities and HE engineering cultures is a complex one, which is difficult to disentangle, women's identities do appear to be shaped by the cultures into which they are assimilated and, as a result, they are continually negotiating between their gendered and professional identities.
- These findings may have significant implications for strategies to widen participation in engineering and for the concept of critical mass, which suggests that an increase in women may destabilise the masculinity of the engineering sector.
- Chapter eight, *Summary and Conclusions,* considers how the research has met its objectives and answered the research questions. It examines some recommendations for ways forward, addresses the contribution to knowledge this research has made, indicates some of the limitations of the research and opportunities for further research and, makes some final conclusions about the research findings.

8. Summary and Conclusions

The conclusion of the thesis seeks to summarise the main research findings, to show how the research has met its objectives and addressed the research questions, to make some recommendations concerning strategies and policies to recruit and retain women in engineering, to emphasise the contribution to knowledge the thesis has made, to highlight some of the limitations of the research and to make some recommendations for further research.

8.1 Summary

The research set out to examine the relationship between the cultures of engineering education and women engineering students' gendered and professional identities, as well as addressing whether, how and why women students challenge or maintain existing cultures. It has considered existing literature on the cross-cutting concepts of culture and gendered and professional identities and on the thematic concerns of career choice and engineering education. It has presented the methodology that underpins the research and the methods used in the processes of data collection and analysis. It has used the empirical notions of career choice and HE engineering culture as a lens through which to explore the theoretical concepts of identity and gender. It has revealed key findings on women's career choices which have led them to enrolment on an engineering course, as well as their experiences and interpretations of that engineering course and their relationships with engineering students, other women students and engineering staff. Finally it is has offered an interpretation of the meaning and implications of the research findings in the context of existing research.

8.2 Objectives

This section addresses how, and the extent to which, the research has met its objectives.

8.2.1 Women engineering students' career choices and the gendering of career decisions

While there has been a wealth of initiatives to increase the proportion of women studying and working in engineering, their impact has been limited. This objective therefore addressed issues that attract women to study engineering and if, and how, this differs

from the factors that attract men. The findings revealed that women and men make career choices based on similar factors (socialisers, knowledge of the engineering professions, skills, abilities and attributes, career rewards, and identity), but that the extent to which these factors are important is gendered. Specific differences were that men were more likely to be influenced by an interest in technical hobbies and extrinsic factors such as salary. Men were also more likely to suggest they had an existing knowledge of engineering. Women, on the other hand, were more likely to be influenced by a specific person who had encouraged them to study engineering, for example, a parent or teacher, their ability in maths and science, and a desire 'to be different' or make a contribution to society.

Women were also found to hold stereotypical views about the type of people best suited to a career in engineering, suggesting, for example, that men are better suited to engineering because of the way the male brain works. This was despite women stating that they were motivated to study engineering because they were good at maths and science. In upholding these views the women appear to be distancing themselves from 'other women', by becoming an exception to the rule. The contradiction is also an indication of a lack of reflection by women about their gender.

In addition a number of women students perceived that their gender may increase their employability as engineers, as companies may be seeking to improve the diversity of their workforce. However, it is problematic since it undermines women's status as 'good engineers' who are worthy of their jobs. It also had a secondary consequence of making women doubt their own abilities. Over the long-term, it also indicates that 'getting in' to industry, may not be the same as 'getting on'.

8.2.2 Women engineering students' experiences of the higher education engineering cultures

Existing research suggests that women are discouraged from pursuing a career in engineering by the dominant masculine cultures of the profession. This objective sought to examine whether these cultures also exist in engineering education and how women experience these cultures. In particular it explored women's experiences of their engineering course and their relationships with other students, with other women and with staff. It showed that many of the issues were salient to all students, with little variation between men's and women's experiences. Women and men were found to be uncomfortable with particular aspects of their courses, including the relevance of the

course, difficulty of the work, content of the work and assessment methods. On the other hand, there was generally a positive regard for the peer camaraderie on engineering courses and the support received from lecturers. This is not to say that these experiences were not gendered. Women were, for example, more critical of the competitiveness between students and often felt that they needed to compete or prove themselves to a greater extent because they were women.

Women experienced a sizeable amount of sexist 'joking', although this was not generally perceived as negative. This may be as a result of women attempting to 'fit in'. Alternatively it may be that women who have chosen to pursue a career in engineering have positive perceptions of the industry and, as such, sexist 'jokes' are interpreted as just that, jokes. However, the cumulative effect of this behaviour should not be underestimated, since after years of 'joking' women may not have the same positive outlooks.

Finally a critical issue was the help and support women engineering students received from lecturers and support staff. This was interpreted in various ways by women, but was clearly something not encountered by men. The help was clearly difficult to reject, but also created some tension with male students and undermined women's attempts to show that they deserved a place in engineering because of their ability. Furthermore, this may act as a barrier to women developing their practical skills, which may have important consequences for their future career progression.

8.2.3 The relationship between engineering education cultures and women engineering students' gendered and professional identities

This objective intended to investigate whether women's identities were shaped by their experiences of engineering cultures or whether their identities informed how they experienced the cultures. It also sought to explore the relationship between women's gender and professional identities and whether these two aspects of identity were compatible or in tension. The engineering education cultures have been shown to have a complex relationship with women engineering students' identities. It appears that women are assimilated into engineering cultures through their attempts to become 'one of the lads', upholding stereotypical ideas about women and men and failing to acknowledge their gendered experiences. This seems to be a result of women identifying themselves as 'engineers' rather than 'women', but at the same time this raises various tensions for women because it is evident that they are not always treated like 'one of the lads'.

Despite women's denial, their experiences are gendered, because it is only women engineers that are subject to sexist jokes and it is only women that receive extra help because they seem to be perceived as less able than their male peers. In fact, while women recognise the problems associated with these issues, they are viewed as having some advantages too. This highlights some of the ambiguities women face in 'doing gender' and 'becoming engineers'. It is also evidence that traditional notions of masculinity and femininity can be performed by individuals of either sex, with women in male-dominated environments combining perceptions of both masculinity and femininity. In this sense, women engineering students' were found to be neither 'typically' feminine nor 'typically' masculine.

8.2.4 Women's attitudes, experiences and environment by engineering discipline

As much of the extant literature on women in engineering has treated the engineering sector fairly homogenously, this research sought to identify any cultural differences between engineering disciplines and women's experiences of these. Some experiences varied by discipline regardless of gender, suggesting that there are nuanced cultural differences between engineering disciplines and that it is not a homogenous sector. For example, Aeronautical and Automotive and Civil and Building engineering students were most likely to say that nobody encouraged them to study engineering. This may suggest that there is more widespread knowledge about what a career in these fields would involve. Aeronautical and Automotive students were also least likely to say that they found their course to be harder than expected, possibly a reflection of the fact that the courses in this department had the highest 'A' level entry requirements. However, by far the most significant discipline difference, as shown by the qualitative and quantitative findings, was that between Design and Technology and the other engineering departments. Design and Technology students were:

- most likely to be influenced in their course choice by teachers, probably because Design and Technology is a specific school subject, unlike engineering;
- least likely to say they wanted to use their maths/science background or that they were good at maths/science at school, reflecting the fact that this department had the lowest 'A' level entry requirements, both in terms of grades and specific subjects;

- most likely to say they found the course more difficult than they expected, again a reflection of the entry requirements, but also the high level of technical content involved in this specific Design and Technology course;

- most likely to say that students were competitive, perhaps reflecting a lack of collaborative work and the departmental culture.

Some of these differences are clearly a result of the discipline differences between Design and Technology and engineering and the different university entry requirements between subjects. However, Design and Technology also revealed some of the most gendered behaviour, which is not satisfactorily explained by subject or discipline differences. For example, more than in any other department investigated, women were perceived to receive more help and support from staff than their male peers. The consequences of this have already been discussed, but it is particularly interesting given that this department also has amongst the highest proportion of women students (24%). One explanation of this may be that when there is a higher proportion of women present, it is harder to personalise or individualise gender biased behaviour or actions. For example, if a woman is treated differently and she is the only woman present, the difference can be attributed to personality or lack of ability, but if the woman witnessed several women being treated in the same way, albeit differently to men, it would be more difficult to explain in the same way. Interestingly this argument may support the critical mass theory, which has been disputed elsewhere in the thesis, by suggesting that there is a 'tipping point' where women have a greater awareness of gender issues (and perhaps as a result to start to challenge cultural norms). However, this does not offer a complete explanation given that Chemical engineering has the highest proportion of women engineering students (27%) and limited differences with the other engineering disciplines in the research.

8.2.5 Implications for strategies and policies to attract and retain more women in engineering education and careers

This objective aimed to address the implications of the findings for strategies and policies to attract and retain women in engineering education and careers. In terms of career choice, the findings indicate that 'individual' encouragers play a crucial role in influencing women's decisions to study engineering. This appeared to be a result of lack of general knowledge about the engineering sector, which suggests that awareness campaigns about engineering need to be much more far-reaching. Given that women tended to cite

their ability in maths and science as a motivating factor in studying engineering, it would also seem appropriate to target 'A' level maths and physics students in recruitment drives.

In terms of HE, the findings are more problematic, since women's assimilation or survival mechanisms in engineering, raise doubts about the concept of critical mass (the idea that once there is a sufficient proportion of women in engineering, traditionally masculine cultures will no longer prevail). This means that in order to break down existing cultures, it is particularly important to gain men's support as well as women's. This may also be beneficial in that the findings suggest changes to the curriculum would make engineering more appealing to both women and men.

These issues are further explored in the recommendations below.

8.3 Research questions

These research objectives discussed above were established to address the two research questions that underpin the entire thesis.

8.3.1 What is the relationship between engineering cultures and women engineering students' gendered and professional identities?

The findings suggest that the relationship between women's identities and HE engineering cultures is a complex one, which can never really be disentangled. It is, for example, questionable whether women actively 'choose' to adopt particular behaviours or whether they adopt behaviour in order to 'get by' in their situation or circumstances. Nevertheless, women's identities do appear to be shaped by HE engineering cultures, which they are assimilated into consciously and subconsciously. Assimilation seems to occur in part as a result of the time women have spent in a male-dominated environment which, in turn, results in a process of normalisation and, in part, by the desire to succeed and survive in this environment. This results in a process of continual negotiation for women between their gendered and professional identities. This is a finely tuned (un)balancing act, in which these women are neither typically female nor typically male.

8.3.2 Do women engineering students challenge or maintain existing engineering cultures? How and why do they do this?

The women students challenge stereotypical notions of femininity simply by being engineers, but specifically by usurping so-called innate differences and by being 'one of

the lads'. However, while they continue to be subject to gendered humour and special treatment, they fail to be 'equal' to their male peers. Furthermore, the process of assimilation and enculturation, particularly the acceptance of subtle forms of discrimination, such as help and sexist humour, means that these women fail to challenge the status quo of HE engineering cultures, which, as indicated above, has critical implications for initiatives aimed at increasing the numbers of women entering engineering and seriously questions the idea that a 'critical mass' of women will kick-start a wave of cultural change in engineering.

8.4 Recommendations

Based on the findings and implications cited above, the research has resulted in a number of recommendations for recruiting and retaining more women in engineering:

8.4.1 Raise awareness

If more women (and men) are to be attracted into the engineering professions, then awareness of the sector needs to be raised, as does access to good information. This needs to be done at several stages. For example, the use of Insight courses can make science and maths 'A' level students aware of the possibility of engineering. However, it is also important to raise awareness before students choose their 'A' levels, as often there is a natural progression from what is being studied at 'A' level, to what is studied at university. Prior to this stage even, it will be important to get girls interested in traditionally male areas. Improving access to information and opportunities suggests the importance of educating key socialisers, such as parents, teachers and careers advisors, in order that girls and boys are not socialised into 'feminine' or 'masculine' roles, respectively, and that information and opportunities are provided to all children regardless of sex.

8.4.2 Greater choice for students

Possible solutions to the male-centred teaching and learning methods in engineering and related courses involve, among other things, introducing greater choice for students, such as the option to choose management or social science modules, or 'softer' engineering modules that address the social and environmental impact of engineering, as Srivastava (1996) suggests. The difficulties with this are that core modules may have to be dropped to make way for change; the volume of work the students had was considered overwhelming, so to introduce additional modules would be unrealistic. Busch-Vishniac and Jarosz (2004) maintain that it is necessary to investigate how the rigour of

engineering education can be upheld while integrating substantial cultural, economic, political, psychological and communications components to attract a more diverse population to the profession. The fact that accredited courses have not been prescribed by the Professional Institutions since 2004 (Dickens and Arlett, 2009) may go some way to encourage innovative teaching methods. Greater emphasis on employability in recent years also means that engineering teaching is being constantly updated to incorporate new areas of teaching such as sustainable development and ethics (Dickens and Arlett, 2009).

8.4.3 Gender awareness training

Given the male-centred approach to teaching, women's gendered experiences and the lack of recognition of gendered experiences by women engineering students, it seems appropriate to suggest that gender awareness training is introduced or incorporated into engineering degree courses for women and men students and staff. This is also important given that the additional help women receive from staff may be a misguided attempt to help them 'fit' into the engineering environment. Moxham and Roberts (1995) suggest that such staff training should address using non-sexist language, avoiding stereotypes, including references to the historical achievements of women as well as men in the field, ensuring that a range of teaching and learning styles are used, and that students make social, ethical and environmental connections and question how issues have been shaped by a male perspective. This approach has been applied to a limited extent, with positive effects. Wiklund (2003), for example, describes how 'gender science' has been integrated into engineering programmes to raise awareness of the ways gender is constructed in technology and the engineering professions. Both male and women students studying 'gender science' thought that the knowledge they gained was important for their future careers. Within the UK, this might involve mainstreaming the 'Let's TWIST' project, created at Sheffield Hallam University (Williams et al., 2002) to increase the recruitment, retention and progression of women in engineering and construction. Training exercises in this project included asking participants what they thought it would be like to be a woman on their course, and a video of women talking about their experiences of engineering cultures, attitudes, teaching and learning.

8.5 Contribution to knowledge

The research has made a significant contribution to knowledge through its in-depth investigation into women engineering students' experiences of HE, as much existing

research in this area has tended to focus on women's experiences in engineering industry or the experiences of women staff in academia. However, as a gatekeeper to the professions, engineering education is, or should be, a key area of concern in terms of retaining women in the engineering sector. Key aspects of the contribution to knowledge are outlined below.

8.5.1 Help and support

The help and support women students receive from lecturers and other staff and the significant impact this has and may continue to have on women, and which has not been raised in the extant literature. This behaviour may be a result of misplaced perceptions by staff that they are supporting women by implementing a positive action approach towards them, with unintended consequences. However, as Martin (2006) argues, this is a demonstration of paternalistic masculinity, which reinforces a stereotype that women need men's help. Setting aside possible explanations for this behaviour, the unintended consequences of these actions had a profound effect on women and creating often conflicting feelings. The help seemed difficult for women to reject and created tensions with male students who saw women receiving favourable treatment. Being treated as a 'special case' also seemed to undermine women's attempts to show that they deserve a place in engineering because of their competence. Some women also seemed to interpret the behaviour as evidence that the engineering industry is friendly and supportive of women. Finally, the behaviour may act as a barrier to women developing their practical skills to the same extent as their male peers, with potentially long-term consequences for women's progression. Again it poses the question of whether 'getting in' is the same as 'getting on' in engineering industries.

8.5.2 Discipline differences

As indicated in section *8.2.4 Women's attitudes, experiences and environment by engineering discipline*, the analysis of discipline differences has shown that Design and Technology has some significant differences to the other engineering departments included in the study, including evidence of strongly gendered behaviour, such as increased help and support from staff. Possible explanations for this have been discussed above.

8.5.3 Assimilation

While other research has indicated that women assimilate to engineering cultures, little of this has shown that this occurs as early as in HE, as demonstrated in this thesis. Women assimilate through their attempts to claim a rightful place in engineering, acceptance of subtle discrimination and a reluctance to associate with other women. Some of these issues overlap or are contradictory, reinforcing the fragmented nature of identity. This may indicate that the issues operate on a subconscious level for women engineering students and as a result of negotiating complex discourses concerning their relationship with engineering and gender. In many ways these actions are evidence of women engineering students 'doing engineering'.

8.5.4 Doing gender

The research has provided an empirical lens through which to analyse the theoretical concept of 'doing gender'. Although 'doing gender' can be difficult to deconstruct, women's assimilation or coping strategies position gender as a site of conflict for women, whereby gender is performed and negotiated, in ways which are often competing or contradictory. This complex and ongoing process of identity appears to occur at times consciously and at others subconsciously, with little reflection by individuals. For example, the process of 'doing gender' and assimilation may be a result of a reaction to specific circumstances (such as sexist humour) or to fulfil specific objectives (such as being a successful engineer). The findings demonstrate that these strategies, or performances of gender, are a finely tuned balancing act that depend on context, the behaviour of others and intended outcomes. It also goes someway to explain the sometimes contradictory attitudes women engineers display. Such gender performances are also part of women's processes to 'create and reinforce' their gender identities. These findings also support post-structuralist arguments that identity is a process rather than a fixed state.

8.6 Limitations and further research

While the research made some important contributions to knowledge, there were also some limitations, which are discussed further below, along with suggestions for further research.

8.6.1 Generalisation

As Järviluoma et al. (2003) mention, any study focusing on gender needs to recognise that variations will be found in particular times and places. Since gender is a fluid social category, which is always being negotiated anew, it is difficult to generalise the research findings to students at other universities or, more importantly, to experienced women engineers, as opposed to engineers at the outset of their careers. Nevertheless, there is no reason to believe that the findings are not generalisable given the correlation between many of the findings presented here and those of other researchers.

8.6.2 Diversity of women's experiences

This research has also considered women's experiences as fairly homogenous and it is necessary for future research to make greater consideration of the heterogeneity of women's experiences. It may be particularly useful to extend the research to other universities where there might not only be a more diverse curriculum, but also a more diverse student population, in terms of ethnicity, class, race, age, sexuality and disability.

8.6.3 Men's experiences

The research has also been primarily focused on women's gendered experiences, but it is important to recognise that not all masculinities are hegemonic and some can even be marginalised. As Järviluoma et al. (2003) explain, the hegemonic 'ideal' masculinity takes different forms in different contexts and situations. It does not correspond to the reality for most men. Further research is therefore required to explore how men are gendered and potentially marginalised by the masculinities that dominate in engineering cultures.

8.6.4 Early career experiences

Research has focused on women's experiences of engineering education, but it is also necessary to consider what happens to women once they leave the education system. Much of the previous research has focused on women's experiences once they have developed their careers in engineering. In addition, Madhill et al. (2007) state that career choice is not finalised when individuals move into their first professional position. Super (1980), for example, suggests that individuals face multiple points of transition throughout their career. It is therefore appropriate that future research should concentrate on women's early career experiences as this career stage may be particularly crucial in developing and establishing women's identities as engineers and their commitment to the

engineering professions. It may also be useful to further investigate women who studied engineering, but pursued an alternative career.

8.6.5 Experiences in other disciplines

This research has only addressed women's experiences in engineering, but it would also be interesting to test the applicability of the findings towards women's experiences and identities in other disciplines, including in social sciences and humanities. For example, do women in these fields make career decisions based on similar factors to the women engineering students? Do women still face a balancing act in negotiating their gendered and professional identities?

8.7 Conclusion

To conclude, this thesis has examined the impact of engineering cultures on women engineering students' gendered and professional identities, as well as exploring the relationship between these aspects of identity. It has shown that, despite some similar experiences between women and men engineering students, career choices and experiences of engineering HE are gendered. Importantly it has revealed how women's enculturation or professionalisation into engineering results in their 'doing gender' in a particular way in order to be accepted as fitting into the life they have chosen as engineers. This is not to say that women are in any way responsible for the lack of women in engineering, but rather that these women are unconsciously shaped by the cultures into which they enter in HE and, perhaps, even earlier when they make decisions to study male-dominated GCSEs and 'A' Levels at school. Nevertheless, this simultaneously results in women's implicit and explicit devaluing and rejection of femaleness; in 'doing' engineering, women have 'undone' their gender, failing to challenge the gendered cultures of engineering, and in many ways upholding an environment which is hostile to women.

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Appendix A: Interview Guide

A. Background Information (All Interviewees)

Course

A Levels

Type of school (e.g. all girls, comprehensive etc)

Work experience

Parents jobs

B. Pathway to Engineering / Career Decisions (All)

When and why did you decide to study engineering at university?

What factors do you think influenced/impacted your decision to study engineering?

- Family – were they supportive
- Society – education, media, friends, careers literature, advisors
- Situation – chance, least effort
- Socio-economic factors – class, race, sex, shortage of engineers
- Individual – personal strengths - self expectations, ability, interests, attitude, need to achieve
- Psychological/emotional – fear of failure/success, lack of confidence/assertiveness, role conflict?

Work experience, beliefs about job opportunities

What career research did you do? Did/do you know any engineers to talk to? How did you rule out other options?

What appeals to you about engineering?

What was it that attracted you to this particular sort of engineering (e.g. civil, mechanical)?

How did you rule out other disciplines?

Why did you want to do a sandwich course? Was it a conscious decision?

Why did you decide to study at Loughborough? Was it your first choice of university?

C. Engineering as Male-Dominated (All)

Did you realise that engineering degrees were mostly populated by males? If so did this bother you?

Were you ever concerned about the lack of women in engineering?

Do you think more women should be encouraged/enabled to take engineering?

What do you think could be done at an early stage in education to encourage them? Should they be encouraged?
What if anything would have encouraged/discouraged you?
What disciplines have your friends gone into (male/female)? Why do you think this is so?
What (characteristics) makes a good engineer? Describe one.
Do men make good engineers? Do women make good engineers? Any differences?
What do you think are the advantages and disadvantages of being a woman in engineering?

D. Course Experiences (All)

What did you expect from your degree programme? Skills taught/type of teaching/gender proportions (students/staff)
What have been the best and worst things about your course so far?
Are you pleased you chose this course? Has the course met your expectations? If so how? If not why not? What did you think engineering would be? Is engineering what you thought it would be?

Influence of Lecturers

Have you been taught by male or female lecturers? Proportions?
Any differences in subjects taught/style of teaching/proportions of male to female students in the group?
Do you find this encouraging/discouraging?
Do female lecturers treat you the same as male lecturers?
Do you have a personal tutor? Male/female? Do you go to them/are they approachable?
Do you go to anyone else for advise on personal/academic areas of concern/worries, etc?
Who or what has been the greatest influence on you since you started your degree course? And in what way?

Influence of Peers

Does the type of teaching you have experienced involve much interaction with other students? For example, do you have to do much group work or presentations?
Do you choose who you work with in groups? How do you decide who to work with? Do you prefer to work with other women? Why? What good/bad experiences have you had of working in groups?

E. For Placement Students only

Placement Preparation

What aspects of university teaching/advice do you think will help you on your placement?
What skills from the course will you take to the placement with you?
Do you have any previous work experience?
What skills did you acquire that you think might be useful on your placement?
Do you feel prepared and ready to go on placement? Has the university done anything to help prepare you for the placement? Do you feel that your educational experience/the way you are taught reflects the reality of what it will be like when you go to work in the industry?

The Placement

Why did you choose to go on a placement? Why do others choose to (or not to) go on a placement? Any differences between male and female students?
Did anyone encourage you, or not, to go on a placement? Either in the university or outside? What are their reasons for arguing so? Did this influence you at all? In what way?

The organisation

Do you know where you are going on your placement yet?
How much say did you have on where to go on placement? What was the advice given to you? By whom?
What attracted you to this company? E.g. type of job, pay, equal opportunities policies, training opportunities, career prospects, proportions of men and women?
What sort of research into the company did you do? Would you prefer another placement? Why?
What do you know about the organisation you will be going to work for?
Where did you find this information (e.g. company literature, other students, internet)?
How involved are/were the university in helping you find a placement?
Are you a sponsored student? Is the placement a requirement? If it wasn't would you still choose to go on it?

Expectations

What are you expecting to get out of your placement? E.g. ability to relate theory & practice, self-confidence, learn about attitudes and practices of management and workers, improve career prospects?

What do you think will be the worst and best things about your placement? What are you most looking forward to/apprehensive about?
Do you know what sort of work you will be doing on your placement?
What do you hope to be doing?
How do you expect work to differ from university? E.g. in what is expected from you, how you are treated, skills you will be using?

F. For Non-placement students only

The Placement

Why did you decide not to go on placement? Would you have like to go on placement?
Do you think there are any particular advantages or disadvantages of going on placement?

Work Experience

Have you had any other experience in the industry? How did you find this? Was it what you expected? What type of work were you given to do?
What were the best and worst things about the experience? Did you enjoy it? Did you face any discrimination?
What did you learn from this? What skills have you gained?
Have you used anything you learnt from the work experience back in the classroom?
Do you think that your educational experience/the way you are taught reflects the reality of what it is like in the industry?

Work

Do you know what type of company you would like to work for when you have finished your degree?
What sorts of things will attract you to a company (e.g. equal opportunities, training opportunities, pay, career prospects etc,)?
How do you think work will differ to university (e.g. in what is expected of you, the type of work you will be doing, skills you will be using, how you are treated etc.)?
What aspects of university teaching/advice do you think will help you in the industry?
What do you think you will take from the course into the workplace (e.g. technical skills, interpersonal skills)?
What do you think will be the best and worse things about working in the engineering industry?

Do you think that the course/university experience prepares you for the workplace? Do you think it should?

G. Career (All)

In terms of your career, where do you see yourself in 2, 5 and10 years time?
What would be your ideal career? What sort of job would be your ideal? Do you think you think you will encounter any difficulties in trying to achieve your career ideal? What? How will you overcome difficulties?
Do you want to work abroad?
Do you think that the career prospects are good in your field of engineering for the sort of career you want?
Are you happy with the career choices so far? What are the best and worse career decisions you think you've made and why? Would you do anything differently if you went through it all again?

H. Culture (All)

What 5 words would you use to describe the culture/characteristics of the engineering industry? If necessary provide a simple definition of 'culture'.
Do you think the engineering culture is male? Why?
Do you think any aspects of the engineering culture will be problematic for you? Why? What will you do to overcome this?
Do you think your educational experiences differ from other students, for example in social sciences?

Appendix B: Index of Interviewees

Summary of Interview Data:

Summary	Total	Women	Men
Interviewees	61	43	18
Interviews	82	64	18
Placement students	42	24	18
Non-placement students	19	19	0
Aero & Auto Eng	11	5	6
Chem Eng	4	4	0
Civil & Build Eng	15	12	3
Design & Tech	13	10	3
Materials Eng	1	1	0
Mech & Manu Eng	17	11	6

Detailed Summary of Interviewees:

Pseudonym	Gender	Department	Interview 1	Interview 2	Focus Group
Adam*	M	Civil & Build Eng	Y		
Alison	F	Mech & Manu Eng	Y	Y	Y
Amanda	F	Design & Tech	Y		
Amy	F	Mech & Manu Eng	Y		
Andrea	F	Civil & Build Eng	Y		
Andrew*	M	Civil & Build Eng	Y		
Anna	F	Civil & Build Eng	Y	Y	Y
Anthony*	M	Mech & Manu Eng	Y		
Barbara*	F	Civil & Build Eng	Y		
Ben*	M	Civil & Build Eng	Y		

Pseudonym	Gender	Department	Interview 1	Interview 2	Focus Group
Carolyn	F	Civil & Build Eng	Y	Y	Y
Catherine	F	Design & Tech	Y		
Chloe	F	Mech & Manu Eng	Y	Y	Y
Craig*	M	Aero & Auto Eng	Y		
Daniel*	M	Design & Tech	Y		
David*	M	Mech & Manu Eng	Y		
Debra	F	Design & Tech	Y		
Elizabeth	F	Design & Tech	Y	Y	
Emily	F	Aero & Auto Eng	Y		
Emma	F	Mech & Manu Eng	Y	Y	
Erica	F	Mech & Manu Eng	Y		
Eve	F	Civil & Build Eng	Y		
Fiona	F	Design & Tech	Y		
Frances	F	Civil & Build Eng	Y	Y	Y
Grace	F	Design & Tech	Y		Y
Hannah	F	Civil & Build Eng	Y	Y	
Hayley	F	Mech & Manu Eng	Y	Y	Y
Holly	F	Mech & Manu Eng	Y		
Isabella	F	Mech & Manu Eng	Y	Y	
Jack*	M	Aero & Auto Eng	Y		
Jackie*	F	Mech & Manu Eng	Y		
James*	M	Aero & Auto Eng	Y		
Jenny	F	Aero & Auto Eng	Y		
Jessica	F	Design & Tech	Y	Y	Y
Jill	F	Civil & Build Eng	Y	Y	Y
Judith	F	Chem Eng	Y		
Julie*	F	Mech & Manu Eng	Y		
Katie	F	Design & Tech	Y	Y	
Kelly	F	Chem Eng	Y	Y	

Pseudonym	Gender	Department	Interview 1	Interview 2	Focus Group
Lee*	M	Design & Tech	Y		
Lisa	F	Materials Eng	Y		
Maria	F	Design & Tech	Y		
Mark*	M	Mech & Manu Eng	Y		
Matthew*	M	Design & Tech	Y		
Melanie	F	Civil & Build Eng	Y		
Michelle	F	Civil & Build Eng	Y	Y	Y
Natalie	F	Civil & Build Eng	Y	Y	
Nigel*	M	Aero & Auto Eng	Y		
Paul*	M	Aero & Auto Eng	Y		
Peter*	M	Aero & Auto Eng	Y		
Rebecca	F	Design & Tech	Y	Y	Y
Richard*	M	Mech & Manu Eng	Y		
Samantha	F	Civil & Build Eng	Y	Y	Y
Sarah	F	Chem Eng	Y	Y	
Scott*	M	Mech & Manu Eng	Y		
Sophie	F	Mech & Manu Eng	Y	Y	Y
Stacy	F	Aero & Auto Eng	Y		
Steven*	M	Mech & Manu Eng	Y		
Tracey	F	Aero & Auto Eng	Y		
Victoria	F	Chem Eng	Y	Y	
Zoe	F	Aero & Auto Eng	Y		

*These interviews were funded by the engCETL research and took place while the students were on their industrial placement.

Appendix C: Questionnaire

EXPERIENCES OF ENGINEERING

***Completing the Survey**: Please use the left hand mouse button to select your answer (only selecting one answer for each question) or type your answers in the grey shaded areas.*

SECTION A – CAREER CHOICE

In this section we would like you to tell us about the things that influenced your decision to study engineering.

1. Please state whether you agree or disagree that the following items influenced your decision to study engineering?	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree
A. I was attracted to engineering because of the high salary	☐	☐	☐	☐	☐
B. Engineering provided an opportunity to do interesting work	☐	☐	☐	☐	☐
C. I wanted the challenge of solving problems	☐	☐	☐	☐	☐
D. I wanted to use my science and maths background without specialising in either	☐	☐	☐	☐	☐
E. I was good at maths and science at school	☐	☐	☐	☐	☐
F. I chose to study engineering with little knowledge of what engineers actually do	☐	☐	☐	☐	☐
G. I knew about engineering because a member of my family is involved in the industry	☐	☐	☐	☐	☐
H. My hobbies and interests are of a technical nature	☐	☐	☐	☐	☐
I. Engineering will be a good degree to have even if I decide not to enter the profession	☐	☐	☐	☐	☐
J. Engineering appealed to me because it is so varied	☐	☐	☐	☐	☐
K. My mother encouraged me to study engineering	☐	☐	☐	☐	☐
L. My father encouraged me to study engineering	☐	☐	☐	☐	☐
M. My careers advisor encouraged me to study engineering	☐	☐	☐	☐	☐
N. My school teacher(s) encouraged me to study engineering	☐	☐	☐	☐	☐

O. Nobody encouraged me to study engineering	☐	☐	☐	☐	☐

2A. Have you ever attended an engineering insight course?

Yes ☐ No ☐

B. If you answered YES please state whether the course encouraged you to study engineering?

Yes ☐ No ☐

3. Did anyone discourage you from studying engineering?

Yes ☐ No ☐

If you answered YES please state who it was that discouraged you from studying engineering:

SECTION B - EXPERIENCES OF HIGHER EDUCATION

In this section we would like you to tell us about your experiences (so far) of engineering or design technology in Higher Education

4. Please state whether you agree or disagree with the following statements about your degree	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree
A. The level of practical work (such as working on real life projects) on the course is just right	☐	☐	☐	☐	☐
B. The engineering curriculum is more difficult than I expected	☐	☐	☐	☐	☐
C. I am pleased I chose to study engineering	☐	☐	☐	☐	☐
D. It is difficult to understand the relevance of some modules	☐	☐	☐	☐	☐
E. Engineering students are competitive	☐	☐	☐	☐	☐
F. Male students are more confident in class than female students	☐	☐	☐	☐	☐
G. Female students get more help in class than male students	☐	☐	☐	☐	☐

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree
H. We always have competing deadlines	☐	☐	☐	☐	☐
I. The balance between coursework and exams in module assessments is just right	☐	☐	☐	☐	☐
J. The course develops interpersonal skills	☐	☐	☐	☐	☐

5. Please state how satisfied you are with the following items about your course	Very satisfied	Satisfied	Neither satisfied nor dissatisfied	Dissatisfied	Very dissatisfied
A. Quality of lectures	☐	☐	☐	☐	☐
B. Support from lecturers	☐	☐	☐	☐	☐
C. Support from my personal tutor	☐	☐	☐	☐	☐
D. Group work	☐	☐	☐	☐	☐
E. Number of teaching hours	☐	☐	☐	☐	☐
F. The friends I've made	☐	☐	☐	☐	☐
G. The quantity of coursework we have	☐	☐	☐	☐	☐
H. Theory	☐	☐	☐	☐	☐
I. Practical work	☐	☐	☐	☐	☐
J. Design work	☐	☐	☐	☐	☐
K. The variety of subjects the course covers	☐	☐	☐	☐	☐

SECTION C - INDUSTRIAL PLACEMENTS

In this section we would like you to tell us your opinions concerning the industrial placement or sandwich year.

6. Have you/do you intend to go on placement?

Yes ☐ *(please go to Q7)*

No ☐ *(please go to Q8)*

7. Why did/do you want to go on placement?	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree
A. For the work experience	☐	☐	☐	☐	☐
B. Because I need the money	☐	☐	☐	☐	☐
C. I needed a break from education	☐	☐	☐	☐	☐
D. To improve my chances of getting a job when I finish university	☐	☐	☐	☐	☐
E. To help me decide what I want to do when I finish university	☐	☐	☐	☐	☐
F. To give me an idea of what industry is really like	☐	☐	☐	☐	☐
G. Personal development (e.g. to increase my confidence and independence)	☐	☐	☐	☐	☐
H. To improve my grades when I return to university	☐	☐	☐	☐	☐
I. It will be an opportunity to apply the theory I've learnt at university	☐	☐	☐	☐	☐
J. It will help me decide what to do for my final year project	☐	☐	☐	☐	☐
K. The year in industry counts towards getting my Chartership	☐	☐	☐	☐	☐
L. Other *(please state)*					

8. Why did you chose/have you chosen not to go on placement?	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree
A. I already have work experience	☐	☐	☐	☐	☐
B. I could not find a placement in a suitable location	☐	☐	☐	☐	☐
C. I thought it would be too difficult to get back into education after a break	☐	☐	☐	☐	☐
D. I want to finish university as soon as possible so I can start earning money	☐	☐	☐	☐	☐
E. I don't think there is anything to be gained from going on placement	☐	☐	☐	☐	☐
F. I could not find a placement where the work I would be doing appealed to me	☐	☐	☐	☐	☐
G. I applied for placements but was not accepted	☐	☐	☐	☐	☐
H. Other *(please state)*					

SECTION D - FUTURE IN ENGINEERING

In this section we would like you to tell us about your career intentions and the type of things you will look for in your chosen career.

9. What area of engineering would you prefer to specialise in? *(please tick only one box)*

Consultancy	☐	Manufacturing	☐
Design work	☐	Don't know	☐
Contracting	☐	I do not want a career in engineering	☐

Other *(please state)*

10. Would you like to go on to further study?

Yes ☐

No ☐

If you answered YES please state the area/subject you would like to study

11. How important will the following be when making a decision to accept a job or when deciding where to work when you leave university	Very Important	Important	Neither important nor unimportant	Unimportant	Very unimportant
A. Salary	☐	☐	☐	☐	☐
B. Location	☐	☐	☐	☐	☐
C. Working Environment	☐	☐	☐	☐	☐
D. People you work with	☐	☐	☐	☐	☐
E. Opportunity to travel	☐	☐	☐	☐	☐
F. Benefits like a company car	☐	☐	☐	☐	☐
G. Training Opportunities	☐	☐	☐	☐	☐
H. Opportunities for promotion	☐	☐	☐	☐	☐
I. Equal opportunities policies	☐	☐	☐	☐	☐
J. Opportunity for flexible working	☐	☐	☐	☐	☐
K. Child-care policies	☐	☐	☐	☐	☐

12. In the future, would you prefer your work role to be:

Managerial ☐
Technical/Specialist ☐
Don't know ☐

13. In your opinion, how important is it for you to get Chartered Engineering status?

Important ☐
Not important ☐
Not applicable (i.e. my subject area does not have chartership) ☐

SECTION E – ABOUT YOU

This section seeks background information necessary for us to interpret your other responses. In NO circumstances will attempts be made to identify individuals.

14. Are you?

Male	☐	Female	☐

15. What is your age?

18	☐	22	☐
19	☐	23	☐
20	☐	24-29	☐
21	☐	30 or over	☐

16. What is your religion?

None	☐	Jewish	☐
Christian	☐	Hindu	☐
Muslim	☐	Buddhist	☐
Sikh	☐		
Other *(please state)*			

19. Which year of study are you in?

Part A
Part B
Part C
Part D
Placement year

20. Which department are you in?

Aeronautical & Automotive Engineering
Chemical Engineering
Civil Engineering
Electronic & Electrical Engineering
Materials Engineering
Mechanical & Manufacturing Engineering
Other *(please state department and course)*

17. What is your ethnic group?

White

British ☐
Irish ☐
Any other White background ☐

Mixed

White & Black Caribbean ☐
White & Black African ☐
White & Asian ☐
Any other mixed background ☐

Asian or Asian British

Pakistani ☐
Indian ☐
Bangladeshi ☐
Any other Asian background ☐

Black or Black British

Caribbean ☐
African ☐
Any other Black background ☐

Chinese or Other

Chinese ☐
Any other ethnic background ☐

18. Which type of secondary school did you attend?

Mixed sex school ☐
Single sex school ☐

The following space is available for any additional comments you would like to make about your experiences of engineering in higher education.

✂.....

If you would like to take part in the prize draw (£50) please complete the details below. Please be assured that these details will be separated from your completed questionnaire and that your answers will remain confidential.

Name:

Email Address:

Thank you for taking the time to complete this questionnaire

Please return your completed survey via email to _____ as an attachment ASAP

Appendix D: Focus Group Prompt

Intro

- Each participant to introduce themselves, saying who they are, what dept./course they are in/on, and where they went on placement.

Task

- Post-it notes write down 1-5 how committed you are to an engineering career on the basis of your placement?
  1=I really don't want to stay in engineering industry
  5=Love it, really want to do engineering.
- Do women want a career in engineering? Why?
- Have views changed as a result of placement?
- What is impact of placement on career intentions?
- How do you feel now compared to how you felt before you went on placement?
- What are your aspirations?
- Is that particular to your placement, work experience, discipline?
- Do you think male students feel the same as you?

Probes

- Do women in industry work in different roles to men in industry? (e.g. health & safety)?
- What level of responsibility did you have on your work placement? Was this different to male colleagues?
- What have you learnt about the engineering culture since being on placement? Break down – hierarchy, managerial styles, relationships, physical environment … How do people feel about this?
- What are the advantages and disadvantages of being a woman in engineering?
- Is the lack of women in engineering an issue? Does gender matter? Is engineering gendered?
- What are the solutions? What should schools, university, industry and government do?

Other questions

- What factors influenced the decision to study engineering?
- Focus on placement preparation – can the university do more to help?
- How useful is the degree to placement?
- What are the main differences between education and work?
- Have you had an appropriate level of responsibility at work?
- Have you faced discrimination at work? As a student, as a woman?
- Has university supported you through the placement?
- How do you feel about getting Chartered?

Conclusion

- Summarise session and clarify views and opinions.
- Need to reach conclusion about the impact of placement on career intentions