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## Researching Cultures in Science, Engineering and Technology: An analysis of current and past literature

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# **Researching Cultures in Science, Engineering and Technology: An analysis of current and past literature**

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Established in 2004 and funded by DIUS, to support the Government's ten year strategy for Science and Innovation, the UKRC works to improve the participation and position of women in SET across industry, academia and public services in the UK. The UKRC provides advice and consultancy on gender equality to employers in industry and academia, professional institutes, education and Research Councils. The UKRC also helps women entering into and progressing within SET careers, through advice and support at all career stages, training, mentoring and networking opportunities.

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## Executive Summary

### 1. Introduction

- This report is a literature review of published research on the cultures of Science, Engineering and Technology<sup>1</sup> (SET) and the impact they have on women professionals employed in the sector.
- The report focuses primarily on the UK perspective, with reference to other Western countries where relevant.

### 2. Background

- The proportion of women in SET remains low despite initiatives aimed at tackling women's entry to the professions. Evidence suggests that increasing the numbers of women in SET occupations on its own is an inadequate strategy for improving women's often problematic experiences.
- The lack of women in SET and some of the obstacles women face in the sector are part of wider societal perceptions that identify SET occupations as men's domains. This is reinforced by the strong duality between hegemonic masculinities (the symbolic dominance of a particular kind (or particular kinds) of man/men that plays a crucial part in the legitimisation of masculine power over women) and technology, which is established in opposition to traditional notions of femininities and, therefore, women.
- The use of the concept of gender in this report recognises that masculinity and femininity are socially constructed and not biologically determined. (For more detailed discussion, see page 17).
- Culture can be seen as a dynamic process that impacts on the beliefs, values and behaviours of organisations and its members. Gender is fundamental to organisational cultures, where the behaviours most valued and rewarded are those typically associated with traditional notions of the masculine, not the feminine. This is particularly the case in professions dominated by men such as those in SET.

### 3. Individualised Cultures

- Industrial changes in SET organisations have led to increasingly competitive and individualised cultures. This means that arguments for increasing women's entry to SET have often been based solely on business needs rather than a move towards an inclusive culture.
- Competition between both companies and individuals means that employers value economic efficiency with less regard for employee well-being. Increasing dependence on workplace relationships also mean that women are more exposed to discrimination.
- The competitive and individualised cultures of SET can also be found in HE, where students compete for grades, even when group work and collaboration is required.

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<sup>1</sup> Those disciplines that fall within the UK Resource Centre for Women in SET remit; see Appendix.

#### **4. Sexualised Cultures**

- The sexualised cultures of SET industries are biologically deterministic, meaning that women in SET are seen as women first and professionals second; successful SET professionals are not perceived as feminine or to possess supposedly feminine qualities.
- The sexualisation of women in SET is displayed by men and women through language, humour, style and appearance, and usually works to undermine women's professional status.
- Women predominantly deal with these cultures through the management of their appearance and acceptance of their colleague's behaviour, since challenging the culture risks further alienation.
- The sexualisation and objectification of women in SET can also mean that they are simultaneously invisible (as successful professionals) and visible (as they are in a minority).

#### **5. Single-Gendered Cultures**

- Organisational cultures in SET can discriminate against women despite the existence of equal opportunities policies, particularly if cultural norms make it difficult for women, and men, to take-up formal opportunities such as family-friendly working policies.
- The dominant culture in SET is long-working hours, task or project oriented work and the expectation of total availability, with anything less interpreted as a lack of commitment to career, profession and organisation. This is particularly significant for women given that they usually have more domestic responsibilities than men.
- SET cultures also militate against women with children, not only because of a lack of suitable policies to support working mothers, but also because success in SET is measured against traditionally masculine norms, such as total commitment, without the 'distraction' of family and other aspects of personal life.
- Gender stereotypes that exist in the wider society are also reflected in SET professions; an assumed association between masculinities and technology can mean that women are pushed into 'softer' areas within SET occupations. These often afford lesser career opportunities.
- The literature also suggests that women can face conflict in establishing their identity, given the perceived incompatibility between femininities and technology. However, there is also evidence that women can be assimilated into occupational cultures, which can lead them to deny the importance of their gender, and ultimately, reinforce existing masculine norms.
- Although networking has been identified as important for career success, women in SET are often excluded from existing networks that can be both professional and social. Whilst women's exclusion may not always be explicit, it often exists because many networking opportunities are based on activities traditionally considered to belong to men.

#### **6. Conclusion**

- Although significant inroads have been made in attracting women to HE courses in some SET subjects, women's representation remains low across the SET occupations.

- The problematic experiences of women in the SET professions have been well researched over the last two decades and, despite some advances and progress, the literature suggests that women's experiences have changed little over this period.
- There is a complex interplay of individualised, sexualised and gendered cultures which combine to shape women's career opportunities.
- Arguments for increasing women's entry to SET have tended to focus exclusively on business needs rather than a move towards an inclusive culture.
- The sexualised and gendered cultures of SET industries are biologically determinist, meaning that women in SET are seen as women first and professionals second. A clear expression of the dominance of masculine cultures within SET organisations is the ideological dichotomy between family and work which is manifested in a number of ways such as through long-working hours, presumptions about women's commitment to family and children and the lack of 'acceptable' part-time working provision.
- The overriding conclusion of this report is that there are many problematic career paths for women in SET organisations. The coping mechanisms women have been shown to adopt tend to be individualistic strategies, and as such have failed to challenge the persisting cultures and structures in SET.
- Whilst the extent to which cultures can be consciously manipulated is contested ground, it is clear that without fundamental change the SET professions seem certain to remain problematic arenas for women to develop their careers within.
- Recommendations for future research include addressing women's diversity within SET and women's experiences of networking in SET, further exploration of the differences between SET professions, disciplines and sectors, how men in SET experience the dominant cultures, and the need to develop a more sophisticated understanding of gender.



## Chapter 1: Introduction

This review aims to synthesise the extant knowledge on the structures, processes and systems that maintain gender inequality in Science, Engineering and Technology (SET). The review collates, reviews and puts into a wider theoretical context the available body of evidence addressing the cultures, structures, behaviours and systems within different SET occupations and sectors, and their possible impact on the exclusion and underachievement of women. The specific objectives of the report are to review:

- cultural indicators such as symbols, styles, norms, values, social interactions, rituals and shared SET identities;
- elements of cultures unique to individual SET occupations, career stages, and types of SET sectors (industry, public sector, enterprise and Higher Education institutions);
- elements of cultures similar across SET sectors and occupations;
- structures, practices and processes which create barriers to the access, acceptance and progress of women, as well as those which are supportive to women;
- possible effects of favouring masculinity and masculine values and attitudes on acceptance and belonging of women in SET sectors; and
- gender stereotypes, and their impact on attitudes towards female staff performing technical and scientific roles.

The primary focus of the report is on professional occupations in SET in the UK. Studies from Europe, the USA, Canada and Australia are also drawn upon where relevant. Technical and craft occupations, and research beyond Western countries were considered to be outside the scope of the report. The study covers the disciplines of SET established by UKRC<sup>2</sup>.

While the focus of the report is on the impact of SET workplace cultures on women, it is important to note that women's segregation and exclusion from particular occupations, such as those in SET, has consequences beyond impacting on women's careers. For example, the Women and Work Commission (2006) found that women who work full time earn between 13-17% less than men who work full time, and that lower earnings leave women at greater risk of poverty than men, particularly in retirement. Furthermore *'the Commission estimates that removing barriers to women working in occupations traditionally done by men, and increasing women's participation in the labour market, could be worth between £15 billion and £23 billion or 1.3-2.0 per cent of GDP'* (2006: 1).

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<sup>2</sup> This accounts for the disciplines defined as SET by the DTI (2006) within which women are under-represented. This includes some subjects allied to medicine, biological sciences, physical sciences, mathematical sciences, computer science, engineering and technology and architecture, building and planning. For a detailed account of the SET fields within the remit of the UK Resource Centre for Women in SET (UKRC), see Appendix 1.

The report draws on literature from a wide range of disciplines, including for example, management, organisational psychology, sociology, social policy and education. This has enabled a broad understanding of SET cultures to be developed.

The literature is organised around three key themes identified in SET cultures, although it is recognised that there are multiple overlaps between the categories:

- *Individualised cultures*, which includes a discussion of increasing competition between companies and employees, lack of unionisation in SET occupations, the tendency for individually agreed pay and contracts, and individualised training and learning in the workplace;
- *Sexualised cultures*, where women are equated with biologically determinist definitions of their sex, and women's sexual identity is placed at the fore in the cultures of SET organisations; and
- *Single-Gendered cultures*, which refers to the subjective, symbolic association between traditional notions of masculinities and femininities and cultural norms prevalent in SET organisations (including the inconsistent relationship between policies and cultures; the long-hours culture prevalent in SET; the conflict between family and work; gender stereotyping; socialisation and identity; and networking and the career ladder).

The report concludes with a discussion of important some ideas and suggestions for future research.

## **Chapter 2: Background**

Prior to analysing SET cultures and their potential impact on women, it is important to provide some background and contextual information. Accordingly, this section of the report begins with a discussion of women's current position and experiences in SET, establishing the need for an investigation of SET cultures. This information is then put into the wider context of popular perceptions of SET and the widely conceived duality between traditional notions of masculinities and technology. After this the report explores some of the literature defining gender and defining organisational cultures and their relationships with gender.

### **2.1 Women and SET**

#### **2.1.1 Women's position in SET**

For more than 20 years, numerous initiatives have attempted to redress the under-representation of women in SET, but their impact has been limited. 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 more recently the UK Resource Centre for Women in SET. Contracted to 2008, the aim of the UK Resource Centre for Women in SET is to increase the participation and position of women in SET. Its mission to establish a dynamic centre that provides accessible, high quality information and advisory services to industry, academia, professional institutes, education and Research Councils within the SET and built environment professions, whilst supporting women entering, returning and progressing in SET careers. While such initiatives have had some success in increasing the proportion of women studying SET subjects, Ellis (2003), amongst others, has suggested we need to understand why there have been so few subsequent significant changes in SET employment for women. HESA (2007) statistics show that in 2005/2006 33.4% of SET students<sup>3</sup> were women. This figure is significantly lower than the average across all subjects (57.3%). In addition, only 13.9% of all women students in HE are studying SET related subjects, compared to 37.2% of men students. The figures also vary widely by SET discipline. For example, women account for 65.9% of students in subjects allied to medicine, 76.4% of polymers and textiles and 70.7% of medical technology students, but only 15.8% in engineering and technology students, and 8% of naval architecture and 8.5% of mechanical engineering students.

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<sup>3</sup> See Appendix 2 for a detailed breakdown of SET disciplines by sex.

**Table 1: Undergraduate & postgraduate students in HE 2005/2006**

	Total HE students	Total Women	Total Men	Women %
Subjects allied to medicine	45900	30250	15635	65.9
Biological sciences	83290	42615	40670	51.2
Physical sciences	82740	34735	48000	42.0
Mathematical sciences	32425	12235	20190	37.7
Architecture, building & planning	56445	17280	39170	30.6
Computer science	120150	27825	92330	23.2
Engineering & technology	136695	21590	115105	15.8
<b>Average - All SET related areas</b>	<b>557645</b>	<b>186530</b>	<b>371100</b>	<b>33.4</b>
Average - All HE subject areas	2336110	1339175	996940	57.3
All HE Students in SET related areas (%)	23.9	13.9	37.2	

**Source: HESA 2007**

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 13.4% of science, engineering and ICT professionals compared to an average 48.7% across all occupations (ONS, 2007).

**Table 2: Professionals aged 16-65 in Science, Engineering and ICT, 2006**

	Total Professionals	Total Men	Total Women	% Women
Science Professionals	117,805	71,228	46,577	39.5
ICT Professionals	431,950	368,958	62,992	14.6
Engineering Professionals	446,640	422,732	23,908	5.4
<b>Average all science, engineering &amp; ICT</b>	<b>996,395</b>	<b>862,918</b>	<b>133,477</b>	<b>13.4</b>
Average all occupations	37,206,681	19,075,146	18,131,535	48.7

**Source: ONS 2007**

There are also a number of distinct structural issues in SET with regard to Higher Education (HE), particularly surrounding course content and curriculum, which impact on the cultures of SET. However there is a tendency in HE for equal opportunities to be identified *'as an employment issue, and not as an issue which relates to the delivery of educational courses and research'* (Davies & Holloway, 1995:13). Other HE-related literature has focused on the

problem of recruitment, rather than course content or approach (Stepulevage and Plumeridge, 1998). Nevertheless, 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).

Bagilhole and Goode (1998) also suggest that academic men have defined not only what is taught in universities, but also how it is taught, in a way that marginalises women. Lewis (1995) also 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'*. This is problematic given the desirability of structuring a science and 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 (Mills and Ayre, 2003). An improved curriculum would make both the climate and content of teaching appropriate to attract and retain both women and men (Sagebiel, 2003).

### **2.1.2 Women's experiences in SET**

The problematic experiences of women in the SET professions seem to be a common concern for academic researchers. Adam *et al.* (2005: 284) state that *'women (still) have a fairly hard time in the IT industry'*, freely reporting discriminatory practices and that this has changed very little over the last 20 years. Research on the careers of women in IT has also highlighted the resilience of unequal pay and gender segregation in the sector (see, for example, Panteli *et al.*, 2000; Shapiro, 1994; Woodfield, 2000). Similar concerns were raised by Glover (2002) with regards to the employment of women in the sciences. Both Davis (2001) and Hynes (2000) argue that the stereotypical and sexist cultures of the science community actively militates against the participation of women. However, it is asserted that recognition and understanding of the gendered cultures of SET organisations is actually low or absent in women themselves; *'notions of women's subordination in gendered power relations or of men's active resistance to women scientists, or ideas about an inherent masculinity in science, are thoughts foreign to most women natural scientists'* (Benckert and Staberg, 2000: 87). This issue is discussed further in section 5.5 Occupational socialisation and gender identity.

Research such as this and the ETAN report (European Commission, 2000) have moved attention on from just increasing the supply of women in SET sectors to the impact of institutional structures, cultures and systems that disadvantage women. Studies have shown, for example, that women are not driven away from technology because of their lack of ability, but rather because of *'an atmosphere of dominant masculinity'* (Sagebiel, 2003). Glover *et al.* (1996) have also indicated that women actively choose not to enter SET careers in the knowledge that they are likely to feel discomfort. This is because when women undertake supposedly 'male work', they upset a widely

accepted sense of order and meaning (Cockburn, 1985). Thus although women can cope with the actual engineering work, they are likely to find it much more difficult to cope with engineering cultures (Evetts, 1998). Thus, some women pay both personal and social costs when they cross the threshold into occupations dominated by men (Bagilhole, 2002). Opportunity 2000 (1996) suggests that this is because young women in SET find themselves working with values, systems and performance criteria which have been established by men for men, and not for women. Because of this, it is argued that it may be better to conceptualise the issue as women *'marginalising themselves, but not necessarily to their disadvantage'* (Glover, 2002: 42). Hence, some have asked whether it is appropriate to persuade women to enter into SET professions that remain so deeply entrenched in traditionally masculine cultures, given the problems they are likely to encounter without adequate initiatives to support them (Carter and Kirkup, 1990; Dainty *et al.*, 2000).

Strategies to increase numbers of women in SET, based on the critical mass thesis<sup>4</sup>, are 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'*. Thus it is possible to distinguish between research and policy that aims for *quantitative* or *qualitative* change with regards to women in SET (Bjorkman *et al.*, 1997); arguably the quantitative approach does not necessitate the organisational change necessary for women to be fully accepted into the cultures of SET, whereas qualitative change focuses on challenging the existing order (Bjorkman *et al.*, 1997). This is a key difference that research on women in SET should highlight and seek to address.

The literature focused upon in this report explores cultural aspects of SET as a determinant of women's exclusion and underachievement, as Glover (2002: 41) states *'the explanation for the slow feminization of science may reside in the culture of science'*. As was stated above, an emphasis on the *quality* of women's experiences (over and above the quantity of women in SET) is actually the starting point for organizational change. This means that SET institutions themselves need to transform. However, inevitably it is more difficult to produce sensitive research that critically examines these organisations, when permission for access is needed (Glover, 2002). This point should be kept in mind, particularly with regard to the clear gaps that exist in the research literature which emerge later in this review.

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<sup>4</sup> The critical mass thesis suggests that a particular number - or critical mass - of women are required in male dominated organisations 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).

The necessary move beyond a focus on critical mass brings us to the remit of this report: that research into SET *cultures* may hold the key to understanding women's experiences and how ultimately, as we conclude, more research is needed to fully understand the climate in which SET professionals work. Here we will focus on existing literature that explores women's experiences in SET, common preconceptions, education, and workplace cultures are highlighted.

## **2.2 Images of SET**

### **2.2.1 Popular perceptions of SET**

SET industries do not operate in isolation from wider society where stereotypical assumptions influence career choice. Also, prejudicial attitudes and behaviour still operate to the detriment of those who are in a minority or disadvantaged position in SET occupations (Davis, 2002; Dainty *et al.*, 2004; Etzkowitz *et al.*, 2000). It is likely that gender differences emerging in early childhood are relevant to careers, particularly as they can narrow the options available to individuals' making career decisions (see for example, O'Neill *et al.*, 1980; Stake, 2003).

Research on preconceptions about the nature and cultures of SET professions has mainly focused on school-age student's perceptions of SET subjects and professions (see for example, Adya and Kaiser, 2005; Blackstone and Weinreich, 1980; Chacon and Soto-Johnson, 2003; Davis, 2002; Etzkowitz *et al.*, 2000; Jorg and Wubbles, 1987; Kekelis *et al.*, 2005; Kelly, 1985; Leslie *et al.*, 1998; Schoenberg, 2001; Shashaani, 1994). However, it is important to note how preconceptions are formed – through a complex dialogue between the dominant cultural image and subsequent effects, thus reinforcing and creating the context in which SET occupations are 'understood'. Evetts (1997), for example, considers that cultural aspects and gendered images have been important in explaining statistical differences between men and women's career achievements. SET professions are considered a man's domain, particularly, it seems, by men themselves (for a discussion of this phenomena in school age children see Stake, 2003).

If we consider engineering, historically its image has been tough, heavy and dirty and associated with machinery. Therefore, in terms of cultural image, engineering is perceived as a man's profession. This is not only because the workforce is predominantly masculine, but because the prevailing cultures and ethos of SET industries appear to be extremely masculine (e.g. Gale, 1994). These cultural images have remained powerful and have helped to reproduce the perception that engineering careers are unsuitable for women (Evetts, 1998). This is a somewhat cyclical process, reinforcing the masculinity of SET industries. Faulkner (2000a) suggests that '*the fact that popular images of both science and technology are strongly associated with the masculine side of these dualisms [women/men, non-technical/technical ...] must be one of the reasons why, in a deeply gender divided world, most girls and women do not even consider a career in engineering*' (2000a: 94). Also, as Grey and Healy (2004) assert, there are forms of technical or 'geek' phobia apparent in society and the image of IT occupations is such that '*it deters women [...] and therefore questions the degree of organisational cultural change that can be*

*expected in the future*' (Grey and Healy, 2004: 40). Siek *et al.* (2006) also argue that breaking the 'geek myth' is key in addressing women's misperceptions about technology careers.

However, men's bias is also crucial in understanding the obstacles that women face when entering professions dominated by men; Stake (2003) refers to the concept of 'stereotype threat', where negative perceptions of women in SET may be the result of the threat they pose to men's domination of the field.

### **2.2.2 Masculinity and SET**

Alongside images of SET as 'tough masculinity', is the dogma of 'masculine' science that stresses rationality, objectivity and neutrality (Rosser, 1998; Stepulevage and Plumeridge, 1998) and its nature as '*hard, intellect-based, complex, concerned with things rather than people*' (Blackstone and Weinreich, 1980: 384). Saraga and Griffiths (1981) suggest that sciences concerned with improving economic production and developing weapons are mostly strongly identified as masculine. Within the technology sector '*computer science remains firmly situated within the domain of masculinist Western science*' (Stepulevage and Plumeridge, 1998: 313) and the ideological resonance of 'skill' and technical ability is deeply entrenched in traditionally masculine identity, and in strict opposition to femininities (this point is discussed in detail later). Furthermore, it is argued by Wallsgrove (1980: 147) that '*science is power so science is defined as masculine*', thus making clear the crucial link between gender and power relations that pervades issue of women's presence in SET. The established relationship between SET and traditional notions of masculinities and the common-sense discourses that surround the SET professional, both in society at large and within the sector in particular, highlights the deep contradictions that women SET professions face in organisational cultures. Their very existence endangers common-sense notions of masculine SET cultures. For further discussion of the relationship between technology and masculinities see Faulkner (2000a), Gill and Grint (1995), Henwood (2000), Murray (1993) and Wajcman (1991).

However, within SET occupations there are cultural distinctions that are made along a perceived masculine/feminine continuum. Whilst SET occupations are generally seen as 'masculine' there are subsections that have been feminised through higher numbers of women in employment, for example biology or pharmacy in the sciences (Crompton and Sanderson, 1990). Similarly McIlwee and Robinson (1992) refer to women's 'resegregation', suggesting that even when women break into areas dominated by men, they often find themselves confined to 'female ghettos'. Women who experience such resegregation are likely to hold positions with lower status and visibility, fewer opportunities for promotion and lower pay in comparison to their men colleagues. Higher numbers of women within a field does not guarantee their advancement and promotion (Ellis, 2003).



### **2.3 Defining gender**

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 when she asserts that 'one is not born, but rather becomes, a woman' (1949, p.267). 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 derivatives. We are therefore trapped by a process of binary opposition, whereby what we affirm with one term, we negate with the other. Butler (1990) has maintained 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).

It is argued that women's unfair treatment stems from men's belief that women are different from them (Benckert and Staberg, 2000). Consequently, women symbolically represent the 'other' in workplaces dominated by men. Essentialist conceptions of gender not only juxtapose men and women, but also dichotomise the masculine and feminine in such a way that women who 'succeed' in traditionally masculine domains are perceived to 'fail' in supposedly feminine domains. As Van den Brandt suggests '*the image of a good scientist does not reflect the image of femininity*' (2006: 3). Thus, Moore *et al.* argue that this can explain why working women face difficulties; '*the conflicts and very 'real' consequences generated by essentialist versions of 'woman' (and 'man'), in which women who excel in one sphere of life (career, public) 'cannot' simultaneously excel, or supposedly even 'cope', in another (carer, private/domestic)*' (Moore *et al.*, 2005: 14).

Not only do SET cultures express an essentialist construction of women, much research on SET also emphasises differences between women and men (Stepulevage and Plumeridge, 1998). This may disavow similarities between men and women, and differences between women and between men. For example, O'Connor *et al.*'s (2006) exploratory study of founders of ICT companies in Ireland focuses on the differences between men and women, in the work they do and the approaches they adopt to investigate co-entrepreneurial partnerships. Martin and Wright's (2005) study of women run ICT businesses also suggests that they have particular experiences, as distinct from men. However, it is argued that the focus upon *difference* leads to '*the polarization of female and male, and to the subordination of women*' (Benckert and Staberg, 2000: 86).

Conversely some argue that we should not fall into assuming a 'false-difference trap' (Benckert and Staberg, 2000) as there may indeed be some commonality in women's experiences of being the 'other' in workplaces dominated by men. However, in developing strategies for change researchers and policy-makers should be aware of the difficulties with the issue of similarity and difference and how this can work to actually reinforce the

dominant cultures. In the USA, Fox (1998) highlights how the problem of women in science and engineering is defined following individual and structural explanations – often the ‘nature’ of women (conceptualised as distinctly different from men) is focused upon, and so change within women’s behaviour and attitudes is seen as the solution to inequality. ‘*Attempts to fit individuals to existing structures of education and the workplace meet fewer barriers and obstacles than do efforts to change organizations and their hierarchies*’ (Fox, 1998: 221). Wajcman (1991) suggests this is part of the ‘deficit model’, which locates the problem of science and women in the women themselves, and ultimately fails to challenge the gendering of science as masculine.

#### **2.4 Defining culture**

Prior to addressing cultures in SET, it is useful to provide a working definition of what is meant by ‘culture’. The culture of an organisation describes the unique way in which people act or interact within it (Greenwood, 1997, in Agapiou, 2002). Smircich (1983) identifies two broad theoretical approaches. Organisational cultures 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 may be added which suggests that cultures are something an organisation *does* to its members and society. Broadly, this report utilises the second and third conception, where cultures represent *dynamic* processes that are expressed by and through organisational discourses and ideologies. Wajcman (1998) suggests that cultures are both produced and reproduced through the negotiation and sharing of symbols and meanings. Crucially, cultures are 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 cultures 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, which Brown (1995) identifies as *subcultures*.

Organisational culture(s) 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 cultures, the organisation’s leaders, the nature of its business activities, and its environment. The cultures of an organisation are thus the product of a variety of factors; it pervades all aspects of workplaces and has a great influence on the occupational identities 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.

For the purpose of this report, we adopt Brown’s (1995: 9) definition of organisational cultures with a slight addition 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 cultures 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 cultures and structures are 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 have highlighted the *cultural* nature of what is seen in such 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.

In discussing organisational cultures, 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, it is important to emphasise the importance of a culture that works for *all employees* and enables harmony, cooperation and greater motivation, in the context of SET organisations it may be argued that the traditionally masculine-gendered cultures can be increasingly experienced as 'dysfunctional' in a more progressive, mixed-sex workplace, which also includes men who do not subscribe to traditional notions of masculinities.

Organisations can be seen as cultural systems that simultaneously promote 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.

#### **2.4.1 Gendered cultures**

In addition to this, many leading researchers have argued that there is a gendered aspect to cultures (see for example, Hofstede, 2003; Mills, 1988). McIlwee and Robinson (1992: 5) suggest that workplace cultures are the medium in which gender behaviours interact with opportunities created by organisational structure. While gender can be considered as only one aspect of cultures, it is also suggested that gender is fundamental to the cultures 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 single gendered, in spite of changes in the mix of 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). The argument here is that the behaviours most

valued and rewarded in SET organisations are reflective of those typically associated with the traditionally masculine, rather than femininities or alternative masculinities. 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 single-gendered cultures are usually pervasive, tenacious and resistant to change. Faulkner (2005a: 16) asserts that gendered occupational cultures are '*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 masculinities<sup>5</sup> and engineering lies in the social construction of engineering as a traditionally masculine issue and the polarisation of female/male. 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 cultures dominates, it is argued that they experience 'culture shock' (Hofstede, 2003).

Itzin (1995) powerfully characterised single-gender cultures as being 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 traditional masculinities are a dominant element of corporate cultures (Hofstede, 1984). In attempting to define the prevailing organisational cultures under which women are subordinated in local government, Maddock and Parkin (1994) developed the conceptual typology shown in Table 3. This reveals how single-gendered cultures are manifested in the form of attitudes and behaviours in the workplace.

#### **2.4.2 SET cultures**

The dominance of traditionally masculine cultures in SET professions is a key theme explored in this report. A clear expression of this is the common experience of perceived conflict between the family and work, a phenomena that affects both sexes, but gains more resonance with regard to women's maternity rights and experiences of returning to work following maternity leave. An ideological dichotomy between family and work is a common experience across all SET occupations and expresses itself in a number of

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<sup>5</sup> The symbolic dominance of a particular kind (or particular kinds) of man that plays a crucial part in the legitimisation of masculine power over women and in opposition to alternative masculinities. Hegemonic masculinity is, first and foremost, a *cultural* expression of male power, and is therefore socially and historically rooted. As Acker (1991: 174) describes; 'currently, hegemonic masculinity is typified by the image of the strong, technically competent, authoritative leader who is sexually potent and attractive, has a family, and has his emotions under control'. (For more detailed discussions of hegemonic masculinity/masculinities see; Connell, 1987; Segal, 1990).

ways; the long-working hours culture; presumptions about women's desire for children and the 'problem' this causes for the organisation; the lack of culturally 'acceptable' part-time working provision that does not lead to some sort of demotion or interpretation of lack of commitment to their profession. These issues cut across the individualised, sexualised and gendered cultures we explore in this report, thus demonstrating the conceptual power of 'family versus work' for women's experiences in SET professions in the UK.

**Table 3: Organisational gender cultures**

Name of Culture	Key Features of Workplace Environment
<b>The Gentlemen's Club</b>	Women are seen as homemakers, men go to work. Most women cannot challenge it and so accept such attitudes.
<b>The Yard Barrack</b>	In hierarchical structures (such as military organisations) with many layers of management. A bullying culture where sub-ordinates are ignored. Women and part-timers who work in junior posts find it difficult to progress
<b>The Room Locker</b>	An exclusionary culture where sexual references are made to confirm men's heterosexuality. White male bonding through sport and sexual innuendo is rife. Women with power are treated the same as junior women.
<b>The Blind Gender</b>	This makes no reference to an employees home-life or personal circumstances, thereby assuming a level playing field for all employees
<b>The Macho Smart</b>	Economic efficiency is sought at the expense of personal need. Those who cannot work long hours and sacrifice family lives do not achieve.
<b>The Paying Lip Service</b>	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.
<b>The Women as Gate-keepers</b>	Resistance to women managers comes from other women employees with different career/family orientations.

**Source: Maddock and Parkin (1994)**

### **2.5 Summary**

- This section established the context and need for analysis of SET cultures and their potential impact on professional women working in the sector.

- The proportion of women in SET remains low despite initiatives aimed at tackling women's entry to the professions. SET literature also indicates that increasing numbers of women in SET occupations is an inadequate strategy on its own for improving women's often problematic experiences in SET. This highlights the additional need to explore SET cultures to develop an understanding of women's experiences.
- The lack of women in SET and some of the obstacles women face in the sector are part of wider societal perceptions that identify SET occupations as men's domains. This is reinforced by the strong duality between traditional notions of masculinities and technology and in opposition to femininities.
- Cultures can be seen as a dynamic process that impact on the beliefs, values and behaviours of organisations and its members. Gender is fundamental to organisational cultures, where the behaviours most valued and rewarded are those typically associated with the masculine, not the feminine. This is particularly the case in professions dominated by men, such as those in SET.
- The following sections will now explore some of the cultures documented in SET and their possible impact on the exclusion of women.

### Chapter 3: Individualised Cultures

This section outlines how changes in SET organisations feed into increasingly individualised cultures in the workplace that have particular impacts upon women professionals. Whilst these may appear ‘structural’ by definition, these factors have major implications for the cultures within which women work, as gender should be viewed as an integral element of both the structure and the cultures of organisations (Kvande and Rasmussen, 1993). The increasing competition between companies and between employees within the same organisation, lack of unionisation in SET occupations, the tendency for individually agreed pay and contracts, and individualised training and learning in the workplace, leads to an increasing dependence on line management and individual working relationships for the success or failure of careers. Furthermore, professionals in SET organisations are increasingly facing greater risk and insecurity in employment (see for example, Grey and Healy, 2004, with regard to IT contract workers; Langenberg, 2001, with regard to scientific researchers). These contextual factors are argued to have a greater effect on corporate behaviour and hence, the organisational cultures in SET professions, than the development of equal opportunities policies (Webster, 2005).

The primary concern is for organisations to maintain the competitive edge in the capitalist economy – it is within this context that women’s entry into the SET professions has taken place. ‘*The increased competitiveness in the war for talent, high cost of recruitment and training and leakage of SET graduates to other sectors*’ all mean that employers need to adopt a more innovative approach to recruitment (UK Resource Centre for Women in SET, 2005: 3). For example, the UK Resource Centre for Women in SET has found that at any point in time 50,000 women with SET qualifications or experience are not working. As a result, underlying much equal opportunities rhetoric is a business case approach, including the clear desire to provide qualified workers for the SET market due to a skills shortage (Adam *et al.*, 2005), rather than the desire for SET professions to move towards more inclusive and ‘representative’ organisational cultures. This is not to say that the business case is a false one. On the contrary, the business benefits of a diverse workforce are reported to include: increased profitability and inward investment; increased effectiveness and customer satisfaction; reduced likelihood of litigation; reduced staff turnover and recruitment/training costs; reduced loss of corporate knowledge/intellectual capital; more motivated, committed and productive workforce; and reduced absenteeism (UK Resource Centre for Women in SET, 2005<sup>6</sup>).

However, critics of the business case approach, suggest there are implications that ‘*women are perhaps the ‘last resort’ – a suggestion that if some other source were available, WISE would not be needed*’ (Henwood, 1996: 200). Thus it is argued that it is the skills shortage, rather than the

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<sup>6</sup> This document also includes examples of good practice and examples of the impact equality and diversity programmes have had on SET companies.

development of an inclusive approach, that has led more women into SET professions (Devine, 1992) and the retention of women in these professions is commonly extolled as good business sense (Fielding and Glover, 1999). This is important, as this climate clearly places the onus on women to fit into the existing, traditionally masculine cultures of organisations that are employing them out of necessity, rather than a real desire for change. Thus it is argued that it is problematic to sell diversity discourses to the business community, which can leave women vulnerable to political and socio-economic shifts (Griffiths *et al.*, 2006). Therefore, while the business case has made some progress in changing employer perceptions, the use of a business argument alone is problematic. Research has found that women are only too aware of the preference for men employees by SET organisations (Devine, 1992), which leads to women questioning the good intent of equal opportunities policies that do exist and what this means for their presence in SET professions dominated by men. This issue is discussed further in section 5.1 Organisational policies and organisational cultures.

Miller (2002), from her Canadian study of women engineers in the oil industry, found that success is measured only in terms of the bottom line. In other words, human beings are commodified in the pursuit of economic efficiency. Miller suggests that this leads to intense *live to work* norms, with little regard for human needs either within or outside of work; only the fittest and fastest survive. This system values competitive individualism, economic efficiency at the expense of all other criteria, constant productivity and achievement. Miller argues that these values express a particular form of masculinity which is at odds with caring and nurturing values and can become more intense at higher levels.

Etzkowitz *et al.* (2000) also suggest that economic conditions can impact on women's entry and retention in science. They suggest that barriers to entry in both industry and academia are most readily removed in periods of economic prosperity and expansion, and prove more difficult to shift in times of recession. They cite the US, Finland and Portugal as areas where the proportion of women in research and development positions increased post World War 2. However, during periods of increased competition, discriminatory attitudes and behaviours can re-surface.

Changes in management structures within SET organisations are important. Management hierarchies have been reorganised, resulting in the removal of lower management positions and a focus on project and team based work. This places women at a disadvantage as their skills and expertise may function successfully in this context, but this does not necessarily translate into promotion opportunities (Evetts, 1997). Instead, Evetts (1997) argues that promotion in organisations that work this way actually require much greater dedication and career-focus for longer periods of time. Other problematic trends found within the sector include an increasing dependence on relationships with line managers (Wilson-Kovacs *et al.*, 2006) and individualisation of training and learning on the job (Webster, 2005). Often, in SET professions women have to negotiate relationships with managers who are men and/or those who have been well socialised into the traditionally



masculine cultures of the organisation (sometimes other women), which can bring with it some significant difficulties. The participants in Wilson-Kovacs *et al.*'s (2006) qualitative UK-based study on the private IT sector described the negative situations they experienced and the ramifications this had for them and their career: *'silenced by their line manager's attitudes, both women felt set up to fail, with no support, guidance, or information'* (Wilson-Kovacs, 2006: 682). Davis (2001: 384) highlights the importance of work relationships to professional identity and that in the sciences *"who you work with' determines 'who you are"*. Furthermore, Evetts (1994: 110) has argued that *'the ideologies of promotion for merit and individualistic achievement would continue to legitimise the gendering of opportunities and positions,'* suggesting that, on the whole, women will avoid potentially hostile and competitive areas of promotion, but also that there is uncritical acceptance of what career success is (Evetts, 2000).

Overall SET organisations reflect broader trends in society for greater individualisation, competition and uncertainty and individual sectors within SET, for example IT, are argued to epitomise *'an organisational culture which carries the danger of overlooking the particular needs of women [...] based on individualism and ignores the social structures and sources of inequality'* (Webster, 2005: 13). Webster (2005) goes on to argue that there has been a real cultural change in the IT sector, with greater emphasis on employee's personal qualities, meaning success is dependent upon self-advocacy skills. In Grey and Healy's (2004) research on IT contract workers, employees are not allowed to discuss pay rates with each other, thus reflecting *'the secrecy and individualisation seen as indicative of contemporary society'* (Grey and Healy, 2004: 39). Indeed, Knights and Murray (1994) and Wilson-Kovacs *et al.* (2006) also found that the aggressive and competitive macho cultures of IT organisations were difficult for women to work to their own advantage. Although this is not to say that competitive cultures are bad for women and good for men.

There is also discussion in the SET literature about individualisation within the context of HE. Etzkowitz *et al.* (2000) suggest that competing for grades in SET HE is an aspect of the masculinist testing process, which can have negative effects on both women and men, albeit for different reasons. They argue that the extent to which women accept competition in HE and beyond is related to the degree to which they have already accepted competition as a way of relating to others, for example in sport. Powell *et al.* (2004) also found that UK women engineering students describe the education system as competitive. Even group work in HE is limited in its intentions for collaboration because the university structure is individualistic and students achieve, and are awarded degrees, on the basis of individual merit (Powell *et al.*, 2004).

### **3.1 Summary**

- Industrial changes in SET organisations have led to increasingly competitive and individualised cultures. The competitive nature of industry often means that arguments for increasing women's entry to SET have been based solely on business needs rather than a move towards inclusive cultures.

- Competition between both companies and individuals means that employers value economic efficiency with less regard for employee well-being. Increasing dependence on workplace relationships also mean that women are more exposed to discrimination.
- The competitive and individualised cultures of SET can also be found in HE, where students compete for grades, even when group work and collaboration is required.

## Chapter 4: Sexualised Cultures

This section is concerned with how women are continually equated with biologically determinist definitions of their sex, and how women's (hetero)sexual identity is placed at the fore in the cultures of SET organisations, most worryingly in examples of sex discrimination and harassment. Furthermore, it is argued that organizational processes work to naturalize the relationship between organizational power and men's sexuality (Acker, 1991), often in opposition to women's sexuality. This works by making men's sexuality the invisible norm against which women's sexuality is contrasted. In addition it is argued that there is a link between eroticism and technology (Hacker, 1989). Hacker (1989) suggests that in skilled sectors, like engineering, there is a powerful erotic element to work processes, and these processes facilitate dominant organisational hierarchies that rely upon the subjectification of women (Acker, 1991). Thus, 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; this is also noted by Grey and Healy, 2004, with regard to the IT sector). Women are thus sexualised in two key ways: through their visibility as female or by their biological sex, and through their (hetero) sexuality, which is frequently a part of everyday interactions in SET workplaces.

### 4.1 Visibility as female

The experience of a sexualised culture can lead women to try to deny their sex or be asexual. For example, in their discussion of women in the sciences Benckert and Staberg (2000: 93) state that *'the model for a scientist is a man, and as women they strive to be good scientists – that is, nonwomen – at the same time as they are very much aware of their womanhood'*. Similarly, women in the IT sector experience a key area of conflict between their professional and sexual identity; as one woman stated in Moore *et al.*'s (2005: 19) study; *'We [women] have to be a-sexual in order to succeed in our career'*. As women, by biological definition can never be men, or be allowed to maintain an a-sexual status, the sexualised cultures that are expressed within SET organisations is a key force that works against their acceptance in these professions dominated by men.

#### 4.1.1 Women's appearance

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 could have a positive impact, where women may develop a reputation faster than their

colleagues. While it should be remembered that reputations can be good or bad, Carter and Kirkup describe a case where one of their interviewees was used by management as a company ambassador (1990: 78). This experience is supported by Devine's (1992) study where it was felt that the burden of giving career presentations fell disproportionately on women in SET professions. Most of Devine's sample felt that being a woman had been an issue in work. They were made to feel different, and this applied even to those who felt their difference was irrelevant and had not impacted on their career. Similarly, Etzkowitz *et al.* (2000) found that women in science academia will be asked to take on more tasks within and outside the department than men. They suggest that while women are invisible, because they are different, they paradoxically at the same time also become visible because they are different.

Some women may apply body management strategies to make them 'less visible', which usually involves the downplaying of their femininities (Adam *et al.*, 2005). In Adam *et al.*'s (2005) study, one respondent only felt comfortable enough to dress more femininely once her position within the organisation had been established and she felt accepted. However, upon the move towards a more feminine appearance she found that she was increasingly presumed to be a member of support staff, rather than an IT professional. Similarly, an interviewee in Kanter's study is reported as saying, '*You can easily tell the professional women from the secretaries by their shoes*' (1977: 37).

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).

This is also similar to what Sheppard (1989: 146) has described 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.'

## **4.2 Visibility as sexual**

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. A participant in Davis's (2001) American study in the sciences spoke of how during a professional meeting a colleague interspersed his presentation slides with photos of women posing in bathing suits, supposedly to keep his audience awake and engaged. However, he was sending a clear message about women's bodies as an object to be viewed, joked about or enjoyed. This objectification of women's bodies and overt sexist attitudes are also used when women are subjected to various forms of harassment in the workplace, often described as 'silly games', for example the placing of pornographic imagery on women's work computers (Geppert, 1999).

The sex of women, and the potential for heterosexual men to fulfil sexual relationships 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, documented women students' feelings that men '*can't just see you as a friend. There's always got to be a hidden agenda*' (2001: 83). Geppert (1999) also provides a further example of how some academic men prefer the laboratory to be a woman-free zone as they are seen as 'distraction' for men researchers who may fall in love with them (also Adam *et al.*, 2005, found that this exclusion of women from laboratory space continued in IT organisations). As Hynes (2000: 159) argued with regards to her experiences in the sciences in the USA, women are '*demeaned by the sexual tension our anomalous presence catalyzed*'.

### **4.2.1 Sex-biased talk**

A key cultural aspect of the ideology of the masculine sciences is expressed through language. Woodfield (2000) has suggested that the language used in IT is intrinsic to its cultures, consisting of technical jargon and aggressive terminology (such as 'abort', 'crash') which alienates and excludes many women. Grundy (1996) describes widespread use of sex-biased language, e.g. using 'he' when it should be 'he or she'. This is regularly done when jobs of high status are talked about. This sort of language is used in the classroom as well as the workplace. In the classroom, those who regularly use 'he' where they should use 'he or she' can be construed as not only referring to men and describing a man-oriented world, but also as addressing primarily men amongst the listeners. 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,' 'Sweetie' and 'Darlin.' 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.

Grundy (1996) found that in the organisation where she worked, which produced computer systems, men talked loudly, and rarely involved women, in discussion about the operation of the company (who was to use what computers, how computers were configured). She argues that in doing this the men were not only establishing how the business would be organised, but also achieved a sense of dominance over women. Grundy suggests that given that technology is part of men's identity, to discuss it in front of women, and yet exclude them, is to strengthen the bonds between them. Grundy also found that men maintained their dominant position by talking about non-work issues that are perceived to be appropriate for men (and not women), such as cars, drinking and sport (see also Faulkner, 2006, for evidence of this in engineering). When women stated their objections to the noise and conversational norms, they were found to be at fault. One woman in Grundy's research who found the environment difficult to work in, was told to be more flexible if she wanted her contract renewed. In addition, Grundy found that women were rarely heard discussing personal issues, such as family or childcare, and when they did, the so-called women's topics were a source of amusement to the dominant men. One respondent in Adam *et al.*'s (2005) UK study on the IT labour market found the way men talk at work and socially as incredibly isolating; they would go to the pub every lunchtime without inviting her, talk continually about football or in a derogatory way about the women in their lives, whether it be wives or casual girlfriends. Men's conversational discourses in the workplace and the social sphere are dependent on the exclusion of women, thus social life is important because it is another context in which this power game is continued. Conversely, Faulkner (2005b) suggests that the 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. For further information about networking, see section 5.6 Gendered networking and the career ladder.

The subject matter of work discourse is not the only aspect to be taken into consideration; as Davis's (2001) study on women in the sciences found that *style* was also key in the sex basis of organisational language. For science professionals, development of the dominant discourse is crucial to career success, but it seems that '*male mentors modelled and encouraged a different style of talk for male apprentices that women were not privy to*' (Davis, 2001: 383). One of Davis' (2001) participants spoke of how her style of answering questions that were not in the definitive form, led to colleagues doubting her, thus she had to adjust her discourse to come across as more assertive in order to be taken seriously. Thus, women are denied access to the very

discourse *style* that ensures success in the sciences. While Grundy (1996) indicates that men assert their dominance through talking loudly, she also found that where there was an obvious benefit in gaining some information, men would conversely talk quietly. She suggests that men's volume and tone of voice, along with selection of the topic, all function to keep women in their place. 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.

#### **4.2.2 Humour in the workplace**

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'. Henwood (1996: 208) found a *'tolerance on the part of women to men's hostility [...] ignoring the sexism and harassment and not making a fuss'*, a common strategy implemented by women working in SET (Faulkner, 2001; Griffiths *et al.*, 2006). Most had learnt strategies to handle these cultures in a way that they felt retained their professional dignity, without being seen as difficult or humourless. In a few situations they felt defensive or even threatened. 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 masculinist cultures emphasises 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). 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.

### **4.3 Summary**

- The sexualised cultures of SET industries are biologically determinist, meaning that women in SET are seen as women first and professionals second; successful SET professionals are not perceived as feminine or to possess supposed feminine qualities.
- Women predominantly manage these cultures through the management of their appearance and acceptance of their colleague's behaviour, since challenging the cultures risks further alienation.
- The sexualisation of women in SET is displayed by men and women through language, humour, style and appearance, and usually works to undermine women's professional status.
- The sexualisation and objectification of women in SET can also mean that they are simultaneously invisible (as successful professionals) and visible (since they are in a minority).
- The issue of language in SET is particularly epitomised through the use of humour. Humour can be used as a means of embedding risky or unacceptable behaviour in superficially harmless statements or as a means of emphasising power relationships.



## Chapter 5: Single-Gendered Cultures

As outlined in section 2.4 (Defining Culture), gendered cultures are fundamental to the cultures of SET organisations. The symbolic association between the masculine/feminine and various roles and modes of working have consequences for the people working in that organisation. They affect the formal and informal organisational structures, communicate 'acceptability' of particular identities and ways of being, and reward or punish. In this section we outline the predominant gendered cultures that are expressed in SET organisations, and are thus uncovered through research into those organisations. These include: the inconsistent relationship between policies and cultures; the long-hours culture prevalent in SET; the conflict between family and work; gender stereotyping; socialisation and identity; and networking and the career ladder.

The feeling of women's gender being an issue in the workplace is a common experience for women in SET professions as their very existence contradicts cultural norms about what it means to be a man or woman. It is often the case that women suffer if they go against such cultural dictates (Evetts, 1998). In these cases, it is the cultures of the organisation, rather than the type of work expected, that causes discomfort for women. In her discussion of the IT sector, Webster found that *'although many women find computing work attractive in itself, the culture and organisation of computing companies are fraught with obstacles for women's employment, retention and development, and consequently for gender equality in the sector'* (Webster, 2005: 5).

The following section offers a discussion of some of the themes arising from research on SET organisations, and although separated here for the sake of clarity, the issues overlap with each other in many complex ways.

### **5.1 Organisational policies and organisational cultures: an inconsistent relationship**

A key theme in the research literature is the existence of an inconsistent relationship between organisational policies and organisational cultures. Indeed, Brown (1995: 295) argues that *'it is often the case that an organisation's strategy is at variance with its culture'*, but within SET professions the inconsistency is marked and particularly disconcerting to women professionals. Etzkowitz *et al.* found this also applied to SET in academia, *'despite a formal and even at times a strongly stated commitment to non-discriminatory treatment of women, discrimination can be manifested informally'* (2000: 84). In Devine's discussion of engineering and science professions it was found that despite the implementation of equal opportunities policies at an organisational level and the active promotion of maternity entitlement in job advertisements, *'many of the women felt they were little more than a public relations exercise'* (Devine, 1992: 564). Thus there exists a gap between reality and organisational rhetoric (Moore *et al.*, 2005; Elvitigala *et al.*, 2006). As can be shown *'translating policy into practice can be easily sabotaged by individual prejudices and biases'* (Cockburn, 1991, cited in Devine, 1992: 566). The paying of 'lip-service' and the overt

promotion of a liberal approach<sup>7</sup> to equal opportunities may, in fact, be crucial in maintaining the dominant cultures (Bagilhole, 2006). Indeed, Webster (2005) found that family friendly policies were used by IT companies as a 'recruitment tool' that are ultimately undermined within the cultures of the organisation that perceives the 'family' to be a distraction.

Work-life balance policies and practices have the potential to enhance opportunities for women in the workplace (and opportunities for men to be more involved with caring responsibilities), but are often undermined by workplace cultures (Lewis, 2001). The women in Cross and Linehan's (2006) Irish study of high-tech organisations believed that although their organisations provided family-friendly policies, the organisational cultures meant they were realistically unable to avail themselves of these policies. Rather, women perceived that to take up the policies would put them at a distinct disadvantage in comparison to their men colleagues, who rarely used such policies. The majority of respondents also believed that the existence of such policies were very much viewed as a 'women's issue' (see Bagilhole, 2006). Research in this area, also reflects wider research on work-life balance issues, which suggests that in the public sector there is insufficient employer commitment to work-life balance; career progression is affected by balancing care and work; available work-life balance options are not always appropriate; and, organisational culture does not always permit the implementation of initiatives (Visser and Williams, 2006).

The inconsistent relationship between organisational policies and the cultures of the organisation can partially explain the reasons for women not remaining in SET professions, thus it is crucial for SET organisations to properly incorporate equal opportunities or work life balance policies into the *cultures* of the organisation; *'policy statements were but the first step and practical benefits for women were needed to prove their credibility. Actions spoke louder than words'* (Devine, 1992: 564).

It is argued that there are differences between SET organisations in the implementation of formal policies that may ensure better opportunities for women, for example the lack of formalisation of recruitment procedures in smaller, engineering companies is a problem (Devine, 1992; Womeng, 2006). Some argue that the need for cultural change with regards to work-life balance is *'particularly acute in the construction industry'* (Lingard and Sublet, 2002: 515). However, the policy-culture clash was evident across all SET organisations; *'even the most equality-conscious companies revealed internal conflicts between their equality agenda and their other organisational practices, particularly the organisation of working time and in situations of restructuring'* (Webster, 2005: 10).

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<sup>7</sup> A liberal approach to equal opportunities relies on equal and same treatment of men and women. It does not advocate a more proactive positive action approach where different treatment is promoted to achieve equality of outcome.

Thus it is argued that there is a *'pervasiveness of an invisible hegemonic culture'*<sup>8</sup> that dominates professional fields and weakens organisational initiatives that seek to address women's unequal footing' (Wilson-Kovacs *et al.*, 2006: 683). The dominance of traditional masculinities in SET combines with modern masculine occupational ideologies that equate professionalism with long-working hours and greater competition between employees. Furthermore, it could be argued that this issue is related to wider contextual trends (as discussed in section 3. Individualisation) which manifests itself in *'contradictions between the increasingly greedy temporal practices of many organisations with the public policy rhetoric of family friendly policies or work-life balance'* (Grey and Healy, 2004: 39; see also Cosser, 1974 for a detailed discussion of 'greedy institutions').

### **5.2 Long-hours culture: an expectation of 'total availability'**

As the long hours culture can have such a negative effect on women's experiences in SET organisations, it is worrying that this culture has achieved such a dominant status. Grant *et al.* (2000) argue that there now exists a 'clockwork' – a minimal time 'benchmark' – required for success, which is implicitly structured on the lives of men scientists. A recent DTI report (2005) stated that the long working hours culture in IT organisations is one of the reasons why women in their 40s and 50s leave their profession. Lingard (2004), in her research on the Australian construction industry, found that the long and irregular hours culture prevalent in the industry, along with increasing job insecurity, has negative effects on all employees – men and women alike. She found that site-based employees work longer hours than employees based in the head or regional office, which can act as a major deterrent for women pursuing careers in these roles. Davis (2001) found that women in the sciences spoke of the pressure of working 70-80 hours per week in the laboratory and how the long-hours culture was so ingrained where one participant worked that members of the department periodically passed round a sheet on which people documented the number of hours worked, with some colleagues claiming to have worked 90 hours a week. Etzkowitz *et al.* (2000) also found that the commitment to long-hours extends to scientific research in academia, suggesting that the long hours spent in the laboratory is positively interpreted, irrespective of how the hours are spent. This suggests that the long-hours culture is coupled with one of presenteeism.

Project-based working is argued to be particularly time-crucial, where SET professionals work on a project until successful completion, which usually involves the expectation that you will give as much time as is needed (Davis, 2001). Carter and Kirkup (1990) found that because engineering work is often task-oriented rather than time-oriented, there is often pressure to work long hours and for work to spill over into private time. While this pressure is likely to be felt by all employees, it can be particularly significant for women, who often have more domestic responsibilities than men. Woodfield (2000) found that IT professionals also work under a 'project mentality', epitomised by long, non-standard, hours, with commitment to work taking precedence over that to friends and family: *'projects have been organised around technical*

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<sup>8</sup> The dominant culture that overrides other cultures, or subcultures, which circulate within an organisation or society.

*necessities, and non-technical sacrifices have been both expected and routinely made, to meet technical demands'* (2000: 19). In addition to hours, Murray (1993) suggests the project mentality in IT also includes *'the possession of demonstrable competence in the discourse and techniques of 'milestones, deliverables, and objectives''* (1993: 73).

Furthermore, even when staff can work 'normal' hours, there are 'hidden costs': *'the sense that you are not pulling your weight, that others are suffering for you, and that you are missing out on perhaps the most exciting and visible parts [...] the inability or unwillingness to work long hours may be read as an insufficiency of organisational commitment'* (Murray, 1993: 74). The conflict between work pressures and family responsibilities are keenly felt by professionals working in SET and the decision to spend time with family rather than working has real consequences (Davis, 2001). The demands made on employees to be available at weekends and during the evenings, and the expectation that SET professionals will work long-hours without formal monetary recognition place pressure on individuals who may have commitments outside of the workplace. It is argued that *'work-family experiences play an important role in shaping employees' work-related attitudes and behaviours as well as determining individual and organizational well being'* (Lingard, 2004: 992). Women are very conscious of the decisions they make in choosing to prioritise family time above work, as one participant in Davis's (2001) study states *'I don't regret my choice. I only regret that it has a negative effect on my career'*. Thus, *'women, especially those who have family involvements, are systematically disadvantaged in such a world'* (Grant *et al.*, 2000). The particularly gendered conflict between family and work is discussed further in section 5.3 Family versus work.

In Webster's (2005) discussion of IT workers across Europe, including the UK, she describes how they are highly favoured in the labour market, often demanding high wages, which are usually performance related. Most IT workers are employed full-time, which equates to long hours, often spilling over into evenings and weekends. Project work is unpredictable and demands 'total availability' of staff. IT workers do have flexibility in their working lives in the sense that they are able to work from home, which is thought to be a positive aspect for women with families, but the flip-side of this is the expectation to work on client-based projects, usually involving working away from home. This is very difficult for some people with young children, both men and women, and the fact that flexible working usually equates to longer, not shorter, working hours. Thus the availability of flexible working and formal progression policies and practices established in IT companies are juxtaposed with a long working hours culture and a strong focus on work as a priority that ultimately undermines the positive effects these may have for women (and men) in the industry. Indeed, *'reconciliation between professional and private life is difficult for employees (of both sexes) in IT professions'* (Webster, 2005: 8). Lingard (2004), who discusses work-life conflict in detail, found no significant sex differences in work-family life experiences, in fact finding that these experiences are more closely related to work conditions. For more information about this within architecture see de Graft-Johnson *et al.* (2003).

This is particularly important given that men and women with children under 6 (or under 18 if disabled) have the legal right to request flexible working<sup>9</sup>, which can include the hours they are required to work (e.g. less than full time), the times they are required to work (e.g. a later start time), or where they are required to work (e.g. increasing time spent working from home) (EOC, 2005). It is also important for SET workplace cultures to reform to meet the needs of both sexes who are increasingly seeking *'spatial and time flexibility – doing the same work but at different times and in different places'* (EOC, 2007a: 4). While the EOC research (2007a) found that employees do not have the confidence to discuss flexible working with their employers, for fear of 'career death', it also documents a strong business case for increasing flexibility. Employers indicate a positive impact on: premise costs, customer service and satisfaction, employee engagement, absenteeism, well-being and recruitment and retention (EOC, 2007a).

### **5.3 Family versus Work: the gendered 'problem' of maternity leave and the return to work**

Whilst the long-hours culture and inconsistency between policies and cultures that exists in SET organisations can affect both women and men alike, it is with regards to maternity leave and the return to work that the family/work conflict becomes particularly problematic for women in SET professions. Grant *et al.*'s (2000: 63) study of scientists found that there is *'considerable conflict between scientific careers and family life [...] especially [for] women'*. Childcare responsibilities are perceived to undermine career commitment regardless of the differences between women; non-mothers are conceptualised as a 'risk' and mothers as a 'problem' (Devine, 1992).

Similarly, Etzkowitz *et al.* suggest that *'implicitly 'male' standards of behaviour permeate scientific time and space, including a belief that a researcher is most productive when their time is devoted to investigation to the virtual exclusion of all other aspects of life'* (2000: 26). Furthermore they found in their research that many scientists believe it is legitimate to consider family responsibilities when evaluating colleagues, regardless of demonstrated achievement. In addition the Womeng (2006) study indicates that those who employ women have to justify their decision more strongly than they would if they had hired a man. In her study of women computing professionals, Woodfield (2000) found that successful professionals were assumed to have made a choice between work *'excellence'* and the *'baggage of domesticity and mundane relationships'* (Hovenden *et al.*, 1995: 7, quoted in Woodfield, 2000: 18). Often women, who are only too aware of an existing 'anti-family' culture within organisations, will downplay their desire for a family when asked in interviews as *'they knew they would not be employed if they challenged the interviewer on his assumptions'* (Devine, 1992: 566). Webster (2005) outlines how IT companies perceive the family to be a 'distraction' and the implementation of work-life balance or flexible working policies are merely used as a recruitment tool, used to attract the most talented workers, but forgotten in times of recession and therefore not properly incorporated into the

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<sup>9</sup> The legal 'right to request flexible working' is under the Employment Rights Act 1996 (ERA) (as amended by the Employment Act 2002).

cultures of the organisation (see section 5.1 Organisational policies and organisational cultures).

Take-up of work-life balance initiatives in the construction industry have been described as low, usually following traditional gender roles with regards to acceptable levels of family commitment (Lingard and Sublet, 2002). Thus it is usually the individual who compromises, either by renouncing family life altogether or adapting family commitments around their work demands; few achieve success in moulding the career to fit the needs of the family (Grant *et al.*, 2000). For Wyncarczyk and Renner (2006), the conflict over work-life balance explains the gender gap in scientific-based SMEs. However, in their exploration of this issue, they focus upon the time-constraints working mothers face without touching upon how the cultures of the working organisation itself places working mothers at a disadvantage. Whilst research that looks at the issues women face in maintaining a work-life balance in SET organisations is important, it is crucial that we do not take for granted the deeply gendered cultures of the places that women work.

Women still experience clear discrimination surrounding the issue of maternity leave and the return to work; requests for part-time contracts are often agreed alongside some kind of demotion of position within the company, as Webster (2005: 8) describes; *'in some cases it severely limited their progression, with companies demoting part-timers from management roles and excluding them from particular client relationships'*. This lack of flexibility in the organisation of contracts has long-term effects on women's career progression (Moore *et al.*, 2005).

Thus there exists a 'take-up gap' between work-life balance initiatives and the barriers that discourage the utilization of these opportunities (Kodz *et al.*, 2002; Womeng, 2006). The lack of flexible working, the low status and negative consequences associated with changing to part-time work was cited as one of the main reasons women decide to leave, or think of leaving, the IT industry (DTI, 2005). The notion of the 'career break' often works against women as these kinds of new provisions are *'devised exclusively from the companies viewpoint'* (Devine, 1992: 570).

In their discussion of women in the IT sector in the UK, Moore *et al.* (2005:12) note that *'this problematic of combining home/caring and work responsibilities is exacerbated by the need for ICT professionals to keep up with the rapid rate of change in the industry, making even relatively short career breaks risky'*. However, one woman engineer based in Canada spoke positively of how the academic department within which she worked dealt with her impending maternity leave (something they had not had to organise before as she was one of the first women employees); *'let's handle it like a heart attack'* (Geppert, 1999). They treated it with the same flexibility afforded to members of staff who may be away from work for a variety of reasons, such as ill health, bereavement etc. Though how far this approach can be viewed positively for women is questionable due to the problematic equation of maternity rights with illness.

On the positive side, Grey and Healy (2004) found that whilst child rearing is a catalyst for contractual change for the IT workers in their study, the relatively high financial rewards given to IT professionals is seen as a positive situation for working mothers as the money '*provides greater freedom to control hours*' (Grey and Healy, 2004: 33). Thus there are differences experienced by women within SET professions, dependent upon the type of field they work in. Flexibility for all employees with regards to work-life balance initiatives is found to be most desirable, which includes the notion that '*different employees will value different initiatives and that their needs will change over time*' (Lingard and Sublet, 2002: 514). The ability to be flexible with women employees with regard to maternity leave and the return to work is a crucial element that needs to be addressed at a *cultural* level within SET organisations. However, it should be acknowledged that the conflict between personal, family life and work is a common experience for professionals across many sectors, not just SET (Auster and Ekstein, 2005).

#### **5.4 Gender stereotyping**

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 Woodfield, 2000; Adam *et al.*, 2005) women are perceived to be unsuitable for purely 'technical' careers (Webster, 2005). It is claimed they are better communicators and are thus directed towards management or the 'soft' side of SET professions, such as sales, personnel, and desk-based work (Devine, 1992). In contrast, Bennett *et al.* (1999) found that women in construction were pushed into the specialist technical skills rather than managerial roles.

However, the term 'skill' is itself argued to be a highly subjective concept (Grint and Gill, 1995) that works in the favour of men, where work predominantly performed by women is generally deemed 'unskilled'. Within SET industries, it is argued that 'ghettoisation' occurs; where men and women are concentrated in particular areas, and those areas that are dominated by women (for example systems analysts in IT) are culturally understood as lower status (Panteli *et al.*, 1997). Because of the increasingly diffuse nature of the IT sector, which now includes a wide range of occupations, women IT professionals have found ways of forming occupational identities that are more in line with acceptable 'femininities' (Grey and Healy, 2004).

It is important to note that this association between traditional notions of masculinities and technology are accepted within society's common-sense discourse and the cultures of SET organisations (see also section 2.2.2 Masculinity and SET). Women in SET professions are, in most cases, reluctant to openly question this stereotype, despite the clear paradox their existence in the sector poses. Adam *et al.* (2005) found this phenomenon in women's failure to even identify themselves as IT professionals and an '*ambivalence in identifying themselves in terms of technical skills*' (Adam *et al.*, 2005: 288); a finding replicated by Griffiths *et al.*'s (2006) study of women in IT. Indeed, as Adam *et al.* (2005: 290) found, '*A woman feels she is not meant to be technical because she is a woman whilst she cannot be a woman*

*if she presents herself as technical'*, which can lead to a lack in confidence and an 'impostor syndrome' (Adam *et al.*, 2005: 291). 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.

Alongside the perceived unsuitability of women for the purely technical careers in SET occupations, the complementary and corresponding stereotype promotes women's ability as managers; *'employers often assume that women are more comfortable in management than technical roles'* (Webster, 2005: 9). Research in SET organisations reveals that this is relatively common across the sector and is ultimately based on the stereotype that women are better at dealing with people. The seemingly positive stereotype does not, however, undermine established gendered norms or cultures. Thus, as Devine (1992: 567) highlights: *'interestingly, while managers claimed that gender stereotypes would be eliminated, they emphasised their commitment to equal opportunities by extolling the virtues of women as managers'* clearly not recognising the contradictions this posed. It seems that if women must enter SET organisations, they will do so on gendered terms, thus explaining the experience women have of being pushed away from purely technical careers, into management.

However, it is important to point out that men still predominately hold managerial positions in these organisations (Panteli *et al.*, 1997) and the management structure is seen as a 'boys club' (Bennett *et al.*, 1999). Therefore, the apparent acceptance of women managers is not clear-cut as it is argued that the position of women as managers raises fears about potential conflict resulting from women managing men (Devine, 1992). The women managers in engineering in Evetts' (1994) study had experienced varying levels of success with reconciling their professional and gender identity. However, the issues women face in either management or technical professional roles demonstrates that there is no unproblematic career path for women in SET organisations.

On a more positive note, when a woman gains acceptance by men, and when her work is valued, forms of communication normally exclusive to men are extended to include her as well. Gherardi (1994) suggests that when women



are actually accepted into a masculine environment, they are often made the object of displays of appreciation and intimacy that typify the community of men. A remark made to Gherardi on several occasions in her investigation concerned the emblematic 'slap on the back.' This situation is illustrated by Gherardi's story of a young woman engineer in an otherwise all men research team. After rejecting the advances made by her colleagues, the woman was marginalised and teased as an 'angry feminist'. This situation changed dramatically when her boss publicly praised her work and as a sign of appreciation, gave her the 'slap on the back'. Women who succeed in SET professions can experience a great sense of pride and status (Henwood, 1996) as a result of making it in a 'man's world', which is expressed as a pleasurable and empowering experience. Thus, the decision to engage in SET professions *'should be understood within the context of the relative status and value attached to 'men's work' as compared with typical 'women's work'*" (Henwood, 1996: 210). However, the implicit devaluation of womanhood often seems to pass unobserved or is taken for granted.

### **5.5 Occupational socialisation and gender identity: a woman like no other...**

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. She suggests that the assimilation strategy used by the majority of women in her research was similar to what Marshall (1993) described 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. However, Miller highlights the fact that while women can learn masculine rules and behaviours, they cannot directly mirror them. 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).

Etzkowitz *et al.* (2000) found that women face a series of gender related barriers to success in careers dominated by men. Women are typically viewed as 'honorary men' or 'flawed women' for attempting to participate in a traditionally man's realm. They write that *'problems of belonging and identity are linked, because the qualities that women feel they must demonstrate in order to win recognition for 'their right to belong' (especially intelligence, assertiveness, and competitiveness) raise the anxiety that such recognition*

*can only be won at the expense of 'femininity'* (2000: 58). Similarly, Evetts (1997) writes that if the woman is an efficient, competent manager, she is likely to be judged unfeminine, but if she demonstrates the supposedly womanly qualities of care and sensitivity she is likely to be assessed either as an inappropriate and inefficient manager, or as a good *woman* manager (see also Woodfield, 2000, in relation to women in IT). 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'.

Often women apply individualisation strategies when talking of their career decision-making and experiences with regard to SET occupations (Henwood, 1996), where they assert that it is their individual identity, rather than gender identity, that holds most influence. For example, problems in confidence are individualised and attributed to personal failings (Adam *et al.*, 2005). Related to this Henwood (1996) found her interviewees wished to avoid speaking explicitly of problems faced within the 'boys culture' and confusion about the concept of 'equality', thus gender-power relations are negated by women themselves. Similarly, Carter and Kirkup (1990) found that women engineers' sense of identity was individual, rather than as a member of the female sex. 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 Grey and Healy's (2004) research with IT workers, respondents described gendered initiation rituals, where women's skills are put to the test by men colleagues. In some instances this may result in a reluctance to associate with other women, although 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, p.139). Powell *et al.* (2006) found in their study that women were also critical of women engineers who were perceived as using 'feminine tactics' (such as crying) and, perhaps most strikingly, held traditionally stereotypical views of women outside engineering. Maupin and Lehman (1994) also found that, in a study of accounting organisations, it was necessary to suppress or eliminate attitudes and behaviours that would identify individuals as 'typical women'. Powell *et al.* (2006) suggest that adopting an 'anti-woman' approach is a further way of dis-identifying with one's own sex, and arguably a strategy adopted in order to succeed in the workplace. However, 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 (as discussed in Section 2.1.2). 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.

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) 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'* (4). For women, the success of cultural adaptation, may also include the management of their own gender (see also Section 4. Sexualised Cultures). 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 (see note 5 page 19): *'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. Similarly, French (2005), in her British study of women academics in IT, found that some women identify with the dominant masculine discourse. However, MIT (1999), in their US study of women science academics, found that while each generation of women started out in their careers perceiving that sex discrimination had been 'solved' in the previous generation, women later realised that this was not the case. Rather, *'their eyes were opened to the realisation that the playing field is not level after all and that they had paid a high price both personally and professionally as a result'* (1999: 9). However, Jorgenson (2002), noting that women in SET often dispute the impact of gender, questions whether gender is the *'most valid frame of inquiry into how workers define themselves or orient toward others'* (2000: 351).

### **5.6 Gendered networking and the career ladder**

Despite the need to 'fit in' with traditionally masculine workplace cultures (Griffiths *et al.*, 2006) discussed above, informal networks within SET organisations make this difficult for women. Wilson-Kovacs *et al.*'s (2006) research supports others (Dainty *et al.*, 2004; Davis, 2001; Faulkner, 2006; Margolis and Fisher, 2002; Moore *et al.*, 2005; Woodfield, 2002) in finding that women in SET organisations lack the support network that men have in the workplace. Social networks often follow supposedly sex-based roles; revolving around traditionally masculine activities such as sport or drinking, spheres which have traditionally excluded women. Faulkner suggests that it can be difficult for women (and marginal men) to gain access to men's networks, *'not least because they bond through shared interests, humour, etc. at the golf course or over drinking sessions'* (2006: 12). Tierney (1995) offers an account of 'lads' networking and career negotiation in a software company. The existence of 'old boys networks' in the IT sector (Morgan *et al.*, 2004) is not unusual across SET professions as a whole. It is argued that networking is also based upon self-promotion, 'game-playing' and unwritten rules constructed by men (Singh *et al.*, 2002: 77). Adam *et al.* (2005: 293) found a *'continued existence of male-dominated informal social networks within the IT sector'*, for example in weekly mountain biking. Benckert and Staberg (2000) found that women scientists described themselves as being excluded from the men's 'club' and that this affects their chances of gaining research positions due to the fact that decision-making bodies remain dominated by men. Respondents in Moore *et al.*'s (2005) research on women in IT stated clearly that to get on in the IT business it would be easier to be a man. Grodzinsky and Gumbus (2005) agree, *'the small number of women in ICT and even fewer numbers of managers pose special problems for women advancing*

*their ICT careers'* (302). Also, because of the time that informal networking demands, women with family responsibilities are particularly disadvantaged (Grodzinsky and Gumbus, 2005). Etkowitz *et al.* (2000) also discusses the importance of social networks in academic science for future success. They suggest that women are excluded from men's networks and social activities from graduate level and beyond, and argue that *'an isolated individual has fewer intellectual abilities'* (2000: 75).

Davis's (2001) qualitative study of women's experiences in the sciences highlights how social connections play a crucial role in the development of 'insider status'; *'It is through social interaction with old-timers and novices in a community that newcomers come to learn the valued structures, knowledge, ways, practices, talk and artefacts of the group'* (Davis, 2001: 369-370). She found that women were given little access to the traditional networks needed for legitimation in the science community and were actively discouraged from forming their own networks. Thus, gatekeepers within SET organisations can be a limiting factor in the development of the legitimate participation of women (Davis, 2001). Furthermore, the participants in the study talked about how unattractive the prospect of networking in the science community was for them as they experienced it as *'competitive, aggressive, less than honest, discouraging and discriminatory'* (Davis, 2001: 377-378, participants in Benckert and Staberg's, 2000, research also experienced the competitive culture in the sciences in negative terms). The women described how the 'schmoozing' and 'posturing' common in both professional and social settings in the sciences left them feeling uncomfortable.

In contrast, Grodzinsky and Gumbus (2005) found that despite the sex bias of much social activity, both men and women do use networking in the IT sector in the USA. In fact, informal organisational networking between employees is crucial for women's career advancement as *'networking results in securing jobs, especially at a managerial level and, therefore, can be a particularly important career enhancing strategy for women seeking a managerial or executive level position in ICT and business'* (Grodzinsky and Gumbus, 2005: 298). However, despite the importance of networking for career development and evidence suggesting that supportive networks in SET can have a positive influence on women's participation and retention (Kreinberg and Lewis, 1996), many women in SET professions believe that it is hard work and reputation building that enables career development (Evetts, 1994) and do not see this type of 'politicking' as part of the job (Grey and Healy, 2004). Webster (2005: 10) uses the concept of 'promotion through visibility', where workers gain advantage by being noticed in networks in weekly football activities or social drinking in pubs. However, the notion of promotion through visibility throws up, once again, a crucial paradox that women face. As discussed with regard to body management strategies earlier, one of the key issues women face is their visibility as women which can mean that women seek to not stand out at all. In fact, it has been found that greater internal visibility was a *positive* factor for men, but a *negative* for women (Forret and Dougherty, 2004, cited in Grodzinsky and Gumbus, 2005: 303). Clearly, these cultures makes women's social networking and visibility management in the workplace a tightrope along which to tread.

Nevertheless, Faulkner (2005b) stresses that we should not overstate the extent of men-only networks. As a result of conflicting arguments, further research in this area is required, for example, exploring how women in SET professions network successfully, and whether this requires side-stepping the more established informal networks of men.

### **5.7 Summary**

- Organisational cultures in SET militate against women's careers despite the existence of equal opportunities policies.
- The dominant culture in SET is long-working hours, task or project oriented work and the expectation of total availability, with anything less interpreted as a lack of commitment to career, profession and company. This is particularly significant for women given that they usually have more domestic responsibilities than men.
- SET cultures also militate against women with children, not only because of a lack of suitable policies to support working mothers, but also because success in SET is measured along masculine norms, such as total commitment, without the 'distraction' of family and other aspects of personal life.
- Gender stereotypes that exist in wider society are also reflected in SET professions, and the association between traditional notions of masculinities and technology can mean that women are pushed into 'softer' areas within SET occupations which are deemed more suitable for women, but which often afford lesser opportunities for career advancement.
- The literature also suggests that women face conflict in establishing an identity, given the perceived incompatibility between femininities and technology. However, there is also evidence that women are assimilated into their occupational cultures, which can lead women to deny the importance of their sex, and ultimately, reinforce existing hegemonic masculine norms.
- Although networking has been identified as important for career success, women in SET are often excluded from existing networks that can be both professional and social. Whilst women's exclusion may not always be explicit, it often exists because of the nature of many networking activities for men.

## Chapter 6: Conclusion

Although significant inroads have been made in attracting women to HE courses in some SET disciplines, women's representation remains low across the SET occupations. This review has sought to explore the critical and empirical knowledge base to establish how the cultures of the SET professions impact on and shape both horizontal and vertical occupational segregation within them. The problematic experiences of women in the SET professions have been well researched over the last two decades. Although there has been little longitudinal research *per se*, this synthesis of the literature suggests that women's experiences have changed little over this period. It has revealed the complex interplay of individualised, sexualised and single-gendered cultures which combine to shape women's career opportunities. In doing so, it has painted the cultures of SET professions as a problematic arena for women to develop their careers within. The competitive nature of industry often means that arguments for increasing women's entry to SET has been based solely on business needs rather than a move towards inclusive cultures. For women to progress they have to make accommodations which many find unpalatable.

The dominance of traditionally masculine cultures in SET professions is the key theme explored in this report. While gender can be considered as only one aspect of culture, it is fundamental to the cultures of organisations, as has been shown in studies in other sectors. The symbolic association between the masculine/feminine and various roles and modes of working have consequences for the people working in SET organisations. They affect the formal and informal organisational structures, communicate 'acceptability' of particular identities and ways of being and rewards or punishes accordingly. They ultimately shape individual, familial and societal norms through explicit and implicit ideologies that are reinforced and sustained through gendered organisational cultural practice and cut across the individualised, sexualised and single-gendered cultures explored in this report. Some of the key ways in which SET cultures favour (more) men than women are summarised below:

- Competitive workplace cultures mean that employers value economic efficiency more than employee well-being;
- Women are viewed in a biologically determinist way which means they are visible by their sex (they are in a minority) and sexually and invisible as engineers;
- Work-life balance and flexible working opportunities are viewed as rhetorical and as a 'women's issue', despite their availability to men, as a result their take-up is perceived to have negative consequences on careers;
- Success is measured by traditionally masculine notions such as total commitment – family and personal commitments are thus interpreted as a distraction;
- Perceived dualisms between masculinity and technology which exist both within SET and society in general mean that women are often sidelined;

- Women are often assimilated into the hegemonic masculinised culture which can mean that they fail to recognise the impact of their gender and reinforce the traditionally masculine norms;
- Women are often excluded from formal and informal networks, with important consequences for career success.

The review indicates that there are a number of distinct areas where culture change is necessary, including:

- Challenging the perceived duality between masculinity and technology;
- Employers embedding work-life balance and flexible working opportunities, and highlighting their availability to men as well as women;
- Greater recognition from employers of the economic benefits of employee (men and women's) well being.

At the same time, there have been, some positive changes for women in SET. In terms of actual workplace culture, Faulkner (2005b), for example, identified a number of gender inclusive dynamics in engineering workplace cultures, including: respectful interactions between women and men engineers; wide-ranging and inclusive topics of conversation and humour; mixed-sex socialising and close friendships, and; care taken to avoid or challenge potentially offensive jokes and language. Some companies are also making a real impact (further evidence of which is available from the UK Resource Centre for Women in SET<sup>10</sup> and Opportunity Now,<sup>11</sup> as well as from the Royal Society of Chemistry, 2004 and the Athena Project, 1999). An increase in government commissioned reports shows a change in attitudes and the need for cultural change, rather than an onus on women to fit into existing cultures (for example, European Commission 2000, *Science Policies in the EU*; Greenfield et al. 2002, *SET Fair*; People Science & Policy Ltd 2002, *Maximising Returns*; DTI 2003, *A Strategy for Women in Science, Engineering and Technology*; Women and Work Commission 2006, *Shaping a Fairer Future*; European Commission 2006, *SHE Figures*). Policy is also moving in the right direction. For example, the Gender Equality Duty (GED) came into force in April 2007, which means that all public authorities in England, Wales and Scotland must demonstrate that they are promoting equality for women and men and that they are eliminating sexual harassment and discrimination (EOC, 2007b). GED is particularly significant because public authorities have to be proactive in: eliminating unlawful discrimination and harassment, rather than reacting to individuals taking cases against them, and; promoting equality of opportunity, not just avoiding discrimination (UK Resource Centre for Women in SET, 2006).

However, despite some positive steps, the overriding conclusion of this report is that career paths for women in SET organisations tend to be problematic. The established relationship between SET and traditional notions of

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<sup>10</sup> The UK Resource Centre for Women in SET have produced a range of good practice guides and case studies, which are available at:

[http://www.setwomenresource.org.uk/advice\\_services/employers/best\\_practice](http://www.setwomenresource.org.uk/advice_services/employers/best_practice)

<sup>11</sup> Opportunity Now is a membership organisation for employers committed to creating an inclusive workplace for women. Their website includes details on best practice, exemplar employers and benchmarking: <http://www.opportunitynow.org.uk/>



masculinities and the discourses that surround the SET professional, both in society at large and within the sector, highlights the deep contradictions that women SET professionals face in working in the prevailing organisational cultures. The coping mechanisms women have been shown to adopt tend to be individualistic strategies, whereby the management of gender is seen to lie in women's own hands, but such coping strategies have failed to challenge the persisting cultures and structures in SET. Concerns over whether SET professions should be marketed to women given the barriers that they face have re-emerged throughout this period as increasing numbers of women have failed to prevent the reproduction of masculine cultures. Whilst the extent to which cultures can be consciously manipulated is contested ground, it is clear that without fundamental change the SET professions seem certain to remain problematic arenas for women to develop their careers within.

## **Chapter 7: Recommendations for Further Research**

The findings of this review point to a number of recommendations for future research in order to further develop knowledge on women's experiences within SET workplaces:

### **7.1 Women and diversity**

While there has been some success in challenging women's position in SET, most research investigating women's presence in SET subjects in HE and SET occupations assumes a universality regarding women's experiences. A realisation of the intersection between, for example, gender, ethnicity, class, race, age, sexuality and disability, and acknowledgement that women in SET occupations have diverse backgrounds and entry routes into their respective professions is all but absent in the research literature. This is despite arguments that the category 'woman' is not 'homogeneous'. Although there are a few notable exceptions (e.g. Carter and Kirkup 1990; Etzkowitz *et al.*, 2000) future research should examine different (dis)advantages for women engineers as a result of their different experiences and identities.

### **7.2 Women and networking in SET occupations**

In Section 5.6 (Gendered networking and the career ladder) the complex and complicated nature of women's access to informal networking is discussed. Some women either find these networks inaccessible or uninviting, however some women in some sectors do successfully use them. An investigation and analysis of this complex picture would be useful topic for further research.

### **7.3 Separation of different SET professions, disciplines and sectors**

There is a need for a more nuanced analysis of the differences between SET professions, disciplines and sectors and their affect on women's experiences and opportunities. Some studies group all SET sectors together and treat them as homogeneous, whereas other studies concentrate specifically on one sector. It would be a useful piece of research to comprehensively tease out the similarities and differences that occur in both the SET professions and disciplines.

### **7.4 Men and masculinities**

While the research points to the dominance of hegemonic or traditional notions of masculinities in SET cultures, it would be useful to explore how men experience this, and how this differs from women's experiences. For example, how do marginal men experience hegemonic masculinities, and how does women's entry into SET impact on different types of men.

### **7.5 Develop a more sophisticated understanding of gender**

There has been a tendency for most research exploring women and SET to assume essentialist notions of men and women. It is therefore important for all future research addressing gender in SET to develop a more sophisticated understanding of what gender, exploring whether particular types of both masculinities and femininities thrive and languish in SET workplace cultures.

## **Appendix 1 – Disciplines included within UKRC remit**

### **Subjects allied to medicine**

Anatomy, physiology & pathology  
Pharmacology, toxicology & pharmacy  
Medical technology

### **Biological sciences**

Broadly-based programmes within biological sciences  
Biology  
Zoology  
Genetics  
Microbiology  
Sports science  
Molecular biology, biophysics & biochemistry  
Others in biological sciences

### **Physical sciences**

Broadly-based programmes within physical sciences  
Chemistry  
Materials science  
Physics  
Forensic & archaeological science  
Astronomy  
Geology  
Ocean sciences  
Physical & terrestrial geographical & environmental sciences  
Others in physical sciences

### **Mathematical sciences**

Broadly-based programmes within mathematical sciences  
Mathematics  
Operational research  
Statistics  
Others in mathematical sciences  
Others in mathematical & computing sciences

### **Computer science**

Computer science  
Information systems  
Software engineering  
Artificial intelligence  
Others in computing sciences

### **Engineering & technology**

Broadly-based programmes within engineering & technology  
General engineering  
Civil engineering  
Mechanical engineering

Aerospace engineering  
Naval architecture  
Electronic & electrical engineering  
Production & manufacturing engineering  
Chemical, process & energy engineering  
Others in engineering  
Minerals technology  
Metallurgy  
Ceramics & glasses  
Polymers & textiles  
Materials technology not otherwise specified  
Maritime technology  
Industrial biotechnology  
Others in technology

**Architecture, Building and Planning:**

Broadly-based programmes within architecture, building & planning  
Architecture  
Building  
Landscape design  
Planning (urban, rural & regional)  
Others in architecture, building & planning

## Appendix 2 – Undergraduate & Postgraduate students in HE SET disciplines 2005/2006

Source: HESA, 2007.

	Total HE students	Total Women	Total Men	% Women
<b>Average - All HE subject areas</b>	<b>2336110</b>	<b>1339175</b>	<b>996940</b>	<b>57.3</b>
<b>Average - All SET related areas</b>	<b>557645</b>	<b>186530</b>	<b>371100</b>	<b>33.4</b>
<b>Subjects allied to medicine</b>	<b>45900</b>	<b>30250</b>	<b>15635</b>	<b>65.9</b>
Medical technology	8590	6070	2520	70.7
Anatomy, physiology & pathology	17115	11730	5375	68.5
Pharmacology, toxicology & pharmacy	20195	12450	7740	61.6
<b>Biological sciences</b>	<b>83290</b>	<b>42615</b>	<b>40670</b>	<b>51.2</b>
Zoology	3810	2405	1410	63.1
Biology	27075	16375	10705	60.5
Others in biological sciences	5825	3375	2445	57.9
Genetics	2290	1275	1015	55.7
Microbiology	4370	2410	1955	55.1
Molecular biology, biophysics & biochemistry	9945	5455	4485	54.9
Broadly-based programmes within biological sciences	925	460	465	49.7
Sports science	29050	10860	18190	37.4
<b>Physical sciences</b>	<b>82740</b>	<b>34735</b>	<b>48000</b>	<b>42.0</b>
Forensic & archaeological science	8535	5500	3035	64.4
Others in physical sciences	5825	3165	2660	54.3
Physical & terrestrial geographical & environmental sciences	20615	9315	11300	45.2
Geology	8790	3755	5040	42.7
Chemistry	18375	7800	10580	42.4
Broadly-based programmes within physical sciences	1280	540	740	42.2
Ocean sciences	1315	540	780	41.1
Astronomy	2335	680	1650	29.1
Materials science	630	175	450	27.8
Physics	15035	3265	11770	21.7
<b>Mathematical sciences</b>	<b>32425</b>	<b>12235</b>	<b>20190</b>	<b>37.7</b>
Others in mathematical sciences	10	5	5	50.0
Statistics	3370	1375	1995	40.8
Mathematics	26935	10155	16775	37.7
Operational research	810	305	510	37.7
Broadly-based programmes within mathematical sciences	140	45	95	32.1
Others in mathematical & computing sciences	1165	350	815	30.0

	Total HE students	Total Women	Total Men	% Women
<b>Architecture, building &amp; planning</b>	<b>56445</b>	<b>17280</b>	<b>39170</b>	<b>30.6</b>
Landscape design	1955	985	975	50.4
Planning (urban, rural & regional)	11820	5360	6465	45.3
Architecture	19185	7020	12170	36.6
Others in architecture, building & planning	1085	290	795	26.7
Building	22395	3630	18765	16.2
<b>Computer science</b>	<b>120150</b>	<b>27825</b>	<b>92330</b>	<b>23.2</b>
Others in computing sciences	1135	620	520	54.6
Information systems	35765	10960	24810	30.6
Computer science	76250	15310	60945	20.1
Artificial intelligence	580	85	495	14.7
Software engineering	6420	850	5565	13.2
<b>Engineering &amp; technology</b>	<b>136695</b>	<b>21590</b>	<b>115105</b>	<b>15.8</b>
Polymers & textiles	2650	2025	625	76.4
Ceramics & glasses	120	65	55	54.2
Industrial biotechnology	130	55	75	42.3
Materials technology not otherwise specified	3110	990	2120	31.8
Metallurgy	640	200	440	31.3
Chemical, process & energy engineering	6215	1670	4545	26.9
Minerals technology	210	45	170	21.4
Others in technology	9615	1770	7850	18.4
Civil engineering	19830	3380	16445	17.0
Broadly-based programmes within engineering & technology	265	45	225	17.0
Production & manufacturing engineering	7255	1210	6035	16.7
Others in engineering	1590	250	1335	15.7
General engineering	21035	3145	17890	15.0
Maritime technology	1080	135	945	12.5
Electronic & electrical engineering	32795	3905	28890	11.9
Aerospace engineering	7580	785	6800	10.4
Mechanical engineering	21955	1870	20085	8.5
Naval architecture	625	50	565	8.0

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