1 The myth of the neutral computer

1 The first wave: the computer as indeterminate object

The first significant wave of optimism concerning the computer's potential for changing gender relations was fuelled by the assumption that the machine itself was an object of indeterminate gender identity. By the late 1970s, women's progress and participation in the more traditional scientific and technical fields, such as physics and engineering, was recognised as being increasingly problematic, with many feminist commentators concluding that these areas had developed an unshakeably masculine bias. A consensus emerged which held that science and technology – the knowledge which constituted their epistemological fields, the people who inhabited the fields, the artefacts they produced and the cultures that they engendered – had become, in a whole variety of ways, more determined by, and more reflective of, the interests of men than those of women. Although clearly rooted in the domains of both science and technology, the advent of the computer challenged this perspective. It was considered by many to be a relatively novel type of artefact, a machine which was the subject of its own newly created disciplinary field: 'Computer Science' (Poster 1990: 147). The fact that it was not quite subsumed within either of its parent realms led commentators to argue that the computer was also somewhat ambiguously positioned in relation to their identity as quintessentially masculine. As such, it was argued that its future trajectory as equally masculine could not be assumed, and the field of computer science need not be littered with the same obstacles that had hampered previous female forays into scientific and technical areas.

The computer's alleged potential for introducing a new energy into previously male-dominated areas consequently became the basis of expectations that women would play an unparalleled part in the revolution it galvanised. During the late 1970s and early 1980s many commentators and practitioners began to predict that, as compared to other scientific and technical fields, women would both find this area more attractive, and perhaps more importantly, would be less likely to find themselves marginalised within it. Estimates of the numbers of women destined for a

career in computing were significantly inflated by these hopes. Shirley Williams, the British Social Democrat, for example, claimed that 'the computer is sex-blind and colour-blind' (cited in Griffiths 1988: 145; see also Zientara 1987) in support of her belief that women would freely enter the profession as the 1980s advanced. Further, the rationalisations shaping the decision of individual women to enter the field often mirrored those which were buoying up the optimism of the commentators, practitioners and policy-makers. Female computer professionals reported applying for their first job because they believed the area to be 'one of the first businesses with no sex prejudice' (Judith Cowan cited in *The Guardian*, 17 February 1989).

As the 1980s progressed, however, it became increasingly difficult to deny that the expectations and predictions symptomatic of this first wave of optimism were seriously overstated. Indeed, the most salient points to emerge from a retrospective review of the position of women in the computing field over the last three decades is that they have been disproportionately absent from it, that in many significant instances their absence has grown more pronounced over time, and that any inroads made have in fact been far more limited than those made into some more traditional scientific and technical realms during the same period. As Elizabeth Gerver suggested at the close of the 1980s, computing was established as a 'strangely single-gendered world', and although women's under-representation may have varied 'from sector to sector and to some extent from country to country', the evidence of it by that date was so ubiquitous that it tended 'to become monotonous' (1989: 483).

2 Women and computing: a quantitative assessment

As well as women's under-representation, another point emerges from a review of available statistics on the past and current sex distribution of computing cultures in the US and the UK:[1] where women have been present, they have been almost invariably clustered in the lower echelons of the field. These two general observations hold true for almost every specific area of activity we may care to examine, whether it is educational, occupational or recreational.

Computing in education

In the educational sphere in the UK, although the achievements of girls are now proportionately matching, if not surpassing, those of boys even in traditional scientific and technical subjects (HMSO 1994; Equal Opportunities Commission (EOC) 1995–1998), the numbers undertaking

computer science courses remain relatively small, and they become smaller still as qualification status increases. At GCSE level, girls gained approximately 38% of A–C passes in the combined regions of England, Scotland and Wales in the 1993–4 cohort, but they gained only 17.6% of A level (A–E) and Higher (A–C) passes in the same year (EOC 1995).

In the US, the picture is significantly different in relation to children educated to high-school level in computer science. In 1982 girls accounted for 43% of such children, but by 1992 they had overtaken boys and represented 52% (US Department of Education 1995). However, more detailed studies of these figures suggest that boys may have been scoring more highly than girls within the field during at least some of this period (Fetler 1985: 181). The sex distribution of voluntary computer camps and clubs in the US also suggests that the high-school figures mask some persistent underlying inequalities between girls and boys in relation to computing. The ratio of boys to girls in camps during the 1980s has been estimated at three to one (Lockheed 1985: 117; Hess and Muira 1985: 193) and in clubs anything between two to one and twenty to one (Lockheed *et al.* 1983; Becker 1985: 137; Perry and Greber 1990). Where camp enrolment was directly linked to the goal of passing an educational course, indications emerging from a large-scale survey taken in the mid-1980s were that the ratio of boys to girls increased along with course standard and cost, as well as with the school grade of the child. These trends were so marked that those undertaking the survey were led to conclude that, if they continued, future male control of information technology was to be expected (Hess and Muira 1985: 193). Although camps specifically aimed at improving computing competence are uncommon in the UK, the picture which has emerged is not significantly different to that of the US if we look at the sex distribution of computer clubs in schools, which are more commonplace. As research in this area has made clear, such clubs have been invariably over-populated by boys, and organised and supervised by male teachers (Haddon 1989; Spear 1985).

The picture does not improve if we focus upon higher educational establishments. In the US the number of men earning degrees in computer and information sciences far outstripped those earned by women throughout the 1970s, 1980s and early 1990s. Men gained 86.5% of American BA degrees in computing in the period 1971–2, giving them a near monopolistic hold over the field's qualifications. By 1981–2 women were contesting this stronghold by increasing their share of computer science BAs to 35%. However, expectations that this 20% growth signalled that the tide was irrevocably turning against male domination soon floundered. By 1991–2 the proportion of women earning degrees in this

field had once again fallen to 28.7%; and this figure was still falling into 1992–3 (US Department of Education 1994).

UK higher education figures mirror those that have emerged from the US in two important respects. First, in the UK too, against the backdrop of a general increase in the numbers of women entering degree level courses (Hammond and Holton 1991: 30), the numbers of those undertaking computer science have been markedly low. Second, the ratio of men to women on computing courses increased rather than decreased as the 1980s progressed into the 1990s.

The statistics issued by the universities' central agency over the past twenty years tell a dramatic story of falling female numbers in computer science programmes in universities prior to the 1992 Act which precipitated the convergence of polytechnics with universities. From a high of 24% of computer science entrants to universities in 1978, numbers fell to 22% in 1981–2, and by 1985 women were only accounting for 10% of undergraduates in this area. Since the mid-eighties the proportion of female entrants in the field has stabilised at around 12% in universities (Hammond and Holton 1991; Virgo 1993; EOC 1985–1995; Higher Education Statistical Agency, 'Students', 1994; HMSO 1994; University Statistics, 1992–1994; Henwood 1993). However, this tale of substantial decline, which has been repeatedly referred to by many commentators in the field, is slightly misleading as it is the product of research which focuses only on the performance of women in universities and ignores those taking computing at undergraduate degree level in polytechnics. Without factoring in this latter group, the decline looks very steep indeed, and far more pronounced than the US dip. If this additional group is accounted for the picture begins to look more like that which has evolved in the States. HESA statistics which take into account undergraduate degrees earned in both sets of institutions, and which have been compiled subsequently to the abolition of the two-tier system, show women as gaining around 21–22% of all of those earned; a finding which adds support to the view that females, as a group, become increasingly underrepresented in computing at this level as institutional prestige increases, given the lower status endured by polytechnic universities (or new universities) in the UK. Unsurprisingly, this tendency is also to be found in the US where the percentage of women taking computer science classes in the more illustrious institutions approaches only half the national average. In both 1986 and 1996, for instance, only 14% of students attending computer science classes in Harvard were female (Gutek and Larwood 1987; personal correspondance with staff at Harvard University, 22 October 1996).

Similarly, there has been a tendency for women to drop away during

the climb up the higher educational ladder. For instance, although the proportion of women in the US who take MAs in computer science is similar to the proportion taking BAs, females still only account for 10–14% of doctoral candidates in this field, and few have made it into the teaching and research ranks (Damarin 1992: 363; US Department of Education 1994). Similarly, in the UK, although women make up between 20% and 25% of the total number of postgraduates undertaking computer studies (HESA, 'Students', 1994–8; University Statistics, 1992–4), a disproportionately low number make the grades of senior lecturer, researcher and professor (University Statistics, 1992–4). Given these figures it is not surprising that the academic literature of the field in both countries has also become dominated by men. Estimates put women's authorship of articles in computer science at only 5–6% (Damarin 1992: 363).

Computing as a career

Although the diffusion of information technologies through the two economies of the US and UK has clearly led to the contraction of job numbers in many sectors, it has also opened up substantial numbers of new posts within the field of computing itself. Estimates vary widely, but it has been suggested that by 1980 the numbers of such posts had almost doubled (Henwood 1993: 33). In real terms this has meant, for example, that up to 13 million more workers in the US were primarily engaged in computational activity of a technical nature in their daily employment (Zimmerman 1990).

Although growth of this size is impressive by any standards, these new posts have varied greatly in terms of the degrees of remuneration, prestige and the perceived expertise which has been associated with them. Examination of the occupational figures in both the US and the UK reveals the broad continuation of the trends identified above in the educational sphere: women have become concentrated wherever the poorest employment conditions are to be found, whilst men have become overrepresented in the more valued areas such as technical management, systems analysis and programming (Zimmerman 1990; Virgo 1994; Hammond and Holton 1992; Strober and Arnold 1987; Henwood 1993: 32–3; Webster 1995; Wajcman 1991).

To be more specific, women make up approximately 70% and 60% of computer operators in the UK and US respectively (EOC 1995–1998; US Bureau of Labour Statistics 1995), as well as dominating data preparation and entry roles. During the 1980s approximately 92% of such roles were taken by them in the USA and 95% in the UK (Henwood

1993: 33–4). Women have also been over-represented on the front and help desks of computing organisations (Virgo 1993; *Computer Economics Survey*, cited in *The Times*, 8 April 1994). All of these task-domains are situated at the bottom end of the occupational ladder where little respect or remuneration has traditionally been received. However, if we examine the population occupying technical and prestigious roles in computing work, it is clear that women have remained significantly under-represented here.

In the US, throughout the 1980s and into the 1990s, women constituted approximately 31% of programmers (Lockheed 1985; Gutek and Larwood 1987; US Bureau of Labour Statistics 1995, 1996). In the UK the statistical picture is cloudier, but the majority of assessments have pointed to the proportion of women in programming work being significantly lower than this figure, with females probably constituting between 20–25% of the workforce total through into recent years (Kirkup 1992: 275; Virgo 1993, 1994; EOC 1995–1998). The figures are similar for systems analysis work. In the US about 31% of those who have become engaged in this type of work are women (US Bureau of Labour Statistics 1995); and again, this number has remained stable since at least the mid-1980s (Gutek and Larwood 1987). In the UK, as in the case of programmers, women seem to have fared slightly less well than their US counterparts, representing only 16–20% of systems analysts (EOC 1995–1998; Neighbour 1995; Kirkup 1992: 275).

Unsurprisingly, the management stratum within occupational computing has become significantly more male-dominated than other areas. Some estimates claim that women have accounted for a meagre 3% of data processing managers in the UK (Virgo, 1993; Kirkup, 1992: 275; Henwood, 1993: 33), although the 1994 *Labour Force Survey* puts the percentage of females in data processing and computer systems management roles at around 20% (Office for National Statistics, 1994–1998). The role of project management seems to have held more opportunities in the UK for female computer specialists, with most calculations suggesting that they have made up between 14% and 20% of this category (Neighbour 1995: 5; Virgo 1993; *Computer Economics Survey*, cited in *The Times*, 8 April 1994). In the US, women seem to have forged more inroads into this area, although the type of managing undertaken may be strongly determined by sex. Philip Kraft and Steven Dubnoff's 1983 study of software workers claimed that whilst 22% of women were in a managerial role of some description, they were more likely than their male counterparts to be in charge of female workforces, and only 3% of them were destined for a senior management post (cited in Henwood, 1993: 33).

Given the firm segregation of occupational computing along sex lines, with men clustered at the top end of the market and women at the bottom, the fact that large salary differentials have emerged between them during this period should not be surprising. What is more perplexing, however, is that on both sides of the Atlantic salaries awarded for the same types of work have been strongly determined by the sex of the worker. Conservative assessments suggest that female computer professionals in the US have earned a mere 75–85% of their male co-workers' wages for the same work (Zimmerman 1990: 207; US Bureau of Labour Statistics 1995), with some reckonings indicating that women who have received this proportion of men's wages have actually fared better than average (Henwood 1993: 33). In addition, only 1% of women in computing work have been able to break through the $50,000 ceiling which has distinguished the middle management from the executive strata (US Bureau of Labour Statistics 1995). In the UK, it seems that women have received higher (but not equal) proportions of their male co-workers' wages than their American counterparts (Virgo 1993), although it has also been claimed that pay differentials in both countries have been widening in the 1990s rather than contracting (Virgo 1994). Furthermore, as in the US, most UK women have run up against a fairly steep wall around the £25,000 mark (Henwood 1993: 33), and, according to some sources, countenance a permanent cut of between £5,000 and £10,000 per year following a career break (*The Guardian*, 3 May 1994).

The skewing of female computing workers towards the lower echelons and margins has also been reflected in the fact that men have overwhelmingly dominated the mainstream professional bodies. Women have constituted just 12% of the British Computer Society through most of the 1990s (Duckworth, BCS, personal communication of 23 October 1998), and, similarly, they have made up only 10% of America's Association of Computing Machinery (Kohnke, Rubin Response Services, personal communication of 26 October 1996).

Recreational computing

Attempting to measure gender differences in terms of general access to, or experience of, recreational computing is an even more difficult exercise than trying to measure such differences in the more formalised settings of work and educational establishments. It is obviously impossible to gauge with any precision how many females have become regular users of computers at home or elsewhere for entertainment, or for organisational purposes, but again, the evidence which does exist indicates strongly that they have so far represented fairly small proportions of overall numbers,

and that Becker's conclusion that 'recreational computing is almost a uniformly male world' (Becker 1985) remains entirely justified.

From the small but growing stock of in-depth portrayals of computing environments (Weizenbaum 1976; Levy 1984; Kidder 1981; Turkle 1984; Haddon 1989; Hovenden *et al.* 1995), we know that it is the case that males have been far more likely than females to spend their free time engaged in concentrated computational activity. In the first instance, boys have experienced greater general access to computers than girls and have reported more ownership and use of them (Lockheed 1985: 118). Indeed, by the mid-1980s in the UK, having an eleven to fourteen-year-old boy in a household became one of the most important variables linked to the possession of a home computer (Kirkup 1992: 275). In those instances where girls reported ownership, evidence has suggested that their use, and that of their mothers, remained peripheral as compared to that of their brothers or fathers (Glastonbury 1992: 120). Further, with very few exceptions, the evidence indicates that it is boys and young men who have played computer games, who have become hackers and hobbyists, and who have been more likely to become obsessional about information technology (Levy 1984; Cringley 1993; Keller 1990; Haddon 1989; Benston 1988). Early indications have also suggested that the use of the Internet has become strongly sex-segregated. Even in the context of its enormous growth rate during the 1990s, many assessments have put female users at only 10% or fewer (*The Guardian*, 16 September 1993; Herz 1994; Bromley 1995: 5).

Summary

Despite the optimistic beliefs in evidence before the 1980s which held that computing would prove to be a gender-neutral activity, and the computer industry would provide a blueprint for a bright, new future for women in scientific or technology-oriented occupations, it was clear by the end of this decade that women in both the US and the UK were engaging in computational activity of all kinds with significantly less frequency and less ostensible success than men. As Griffiths asserted at the time, 'computers have been appropriated by men – and it has taken them only a little over a decade to do it' (Griffiths 1988: 145). In the majority of areas where women have made tentative inroads, and where the promise of more equal levels of participation and performance between the sexes has been glimpsed, subsequent re-colonisations by men and boys have occurred. Progress has, therefore, nearly always proved to be provisional and fragile, and the default population of the computer field has remained steadfastly male into the 1990s. Although differences

are evident between the UK and US pictures, the grounds upon which some commentators (Newton 1991: 144; Morris 1989: 9) have attempted to make a clear distinction between what they perceive to be the conspicuously bad problems of the UK and the far more favourable circumstances of the US are not robust enough to carry the point. Indeed, suggestions such as Morris's – that the US situation can be considered 'a little more hopeful' because 'a woman in a technical position is a fairly common sight' (Morris 1989: 9) – betray just how tenuous such distinctions are. Whilst the available evidence suggests that the situation may indeed be slightly less grim in the US, the general conclusion that computing on both sides of the Atlantic has become largely male-dominated, and that women face substantial problems within the field, seems unassailable.

A common line of argument for why this quantitative domination by men has occurred hinges on the claim that the computer speedily became an unambiguously masculine artefact following its inception; contrary to hopes that it would maintain an indeterminate gender identity. According to this line of explanation, the quantitative domination is best understood as both a symptom and a cause of the qualitative dominion over the field's culture by a specific brand of masculinity. Rather than being situated equivocally in relation to its parent fields of science and technology, it is suggested that the computer belonged from the first to these two most prototypically masculine realms and that the expectation that it could escape this patrilineage was consequently always utopian. The bases of this claim will be explored in the remainder of this chapter.

3 Computers as culture

There is by now a long-established tradition of speaking of information technology in the same breath as of major, society-wide changes, upheavals and revolutions (Bell 1973; Toffler 1970, 1980). The suggestion has consistently been that IT is strongly, indeed causally linked with the production and reproduction of national and international culture, and mainstream commentaries have primarily concentrated on mapping the past, present and future course of its impact. Fewer commentators have examined the way in which elements of the wider cultural framework itself can influence and determine the nature of the immediate computing environment, or have reflected in detail upon the way the nature of the immediate context continues to surround and shape the production of the technology. This task has largely been taken up by those social theorists who have worked under Marxist, feminist or social constructivist banners (Bijker *et al.* 1987; Cooley 1980; Kramarae 1988; Noble

1984; MacKenzie and Wajcman 1985; Rothschild 1983). A key part of much of their work has been the development of a fuller appreciation of the extent to which the contexts within which new technology is produced and used are distinctive cultures; or an appreciation of the relationship between these cultures and the principal structures giving shape to the wider social framework such as the gender, class, or economic system.

The question of whether or not the field of computing can legitimately be considered to be a distinctive culture, as well as the questions of what kind of culture it may be and how it may be linked to both the production of technical artefacts and to the wider socio-cultural framework, begs the prior, but in this field rarely examined question of what constitutes a culture *per se*. Becker and Geer's definition suggests that for a social space to constitute a specific culture it requires 'a somewhat different set of common understandings around which action is organised, and these differences will find expression in a language whose nuances are peculiar to those and fully understood only by its members' (1970: 134).

In other words, computing's internal social environment must be sufficiently distinct, and distinct in key ways, from non-computing environments. It should, for instance, have produced its own status hierarchy and its own particular set of norms and values, part of which may overlap with the social space outside of the culture, but part of which must also in essence be differently configured and articulated. The particular features of the social grouping must be significant enough to warrant those individuals who constitute the group to meaningfully differentiate themselves from non-members by dint of their membership, even if they do not differentiate themselves from non-members in some other respects. This differentiation must also be in some way integral to their self-perception, as well as to their social identity. Membership should accordingly involve the adoption of signifiers – artefacts, clothing, ways of being and speaking – which mark members out as different and render them recognisable to themselves and others.

Given these criteria, there seem to be valid grounds for thinking about the computing field in cultural terms. It has, for instance, become commonplace for sociologists to point to the high degree of both explicit and implicit differentiation between those who belong to it and those who do not. Research into university students engaging fully with computing for the first time indicates that such a social division is quickly established and thereafter maintained: 'a we–they distinction': the computationally competent and everyone else (Sproull *et al.* 1984: 44).

Although this 'we–they' distinction is essentially based upon the degree of technical knowledge possessed, researchers have consistently pointed out that members of computer culture are bound together by far more